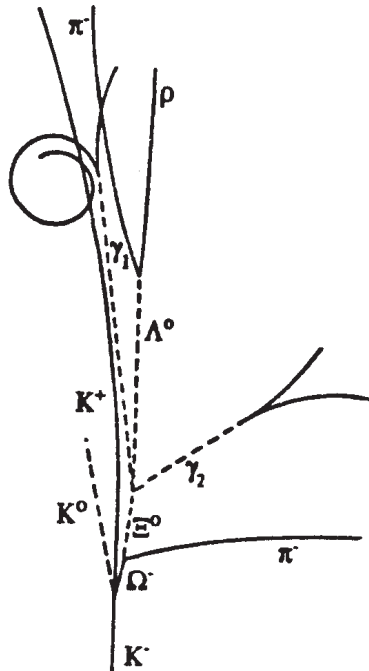


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The Institute for Basic Research

35246 U. S. 19 North Suite 215, Palm Harbor, FL 34684, U.S.A.

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YI-ZHONG ZHUO, Institute of Atomic Energy
P.O. Box 275 (18) Beijing 102413, China
zhuoyz@mipsa.ciae.ac.cn

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Institute for Basic Research

Palm Harbor, FL USA

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Scientific Advisor, Hadronic Technologies Inc.

Editor, Journal of Unconscious Psychology

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**GENERAL DEFINITION OF THE REST ENERGY:
EVIDENCE FROM THE PRIMORDIAL UNIVERSE
A NEW THEORY**

Dr. Emad Eldieb
eeldieb@yahoo.com

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Abstract

The goal is to search for the conditions required for a compact closed sphere filled with baryonic particles in a bound state to have rest energy simulating to that of an isolated, free single particle: zero-internal electric and quantum energies. When we begin and return all the relativistic relations to the original relativistic rule: speed of light is constant regardless the motion of the source or the observer, we will discover a general new definition of the rest energy. This proposed rest energy of the entire sphere gives (and is realized by) a physical meaning for the imaginary relativistic solution: $m^2 = -m_0^2$

Keywords: Quantum degeneracy pressure, Electric field, Gravitational potential, Rest energy, Negative mass.

Introduction

Let us begin from the fact that the speed of object never exceed speed of light [1], and from the common definition of the inertial rest state: m_o , r_o and E_o of an isolated baryonic particle which is stated by the Einstein's famous equation:

$$k \frac{e^2}{r_o} = E_o = m_o c^2 \quad [2]$$

This paper searches in the conditions required for new general definition of the above equation to include a closed compact non-conducting sphere S, formed of sub-atomic particles, and taking the form

$$(E_o)_s = E_o n = n m_o c^2 = M_o c^2$$

This system (which has a defined density, and defined physical properties) has net kinetic energy equals zero: electric E_e , magnetic E_m , quantum E_q , and the small gravitational E_g

$$E_e + E_m + E_q + E_g = 0$$

The synonym meaning of the above form is to say that; the kinetic energy of the electromagnetic field E_e inside our sphere is zero, if and only if we succeeded to put the whole sphere on the form of Einstein's equation. To do that, we have to begin from looking for a formula to fix the Coulomb equation on the form of Einstein's equation. So, let us put the kinetic energy of the electric field inside our sphere (which is the half of the electromagnetic field in our case) in the form of: $\frac{1}{2} k \frac{e^2}{r_o} = \frac{1}{2} m_o c^2$

Now, subtracting the small term E_g gives the relativistic relation:

$$E_e + E_m + E_q \approx \text{nonzero positive quantity}$$

The above sign (\approx) guarantees that we deal with real subatomic particles whose speed never equal that of light ($v \approx c$). To keep the above two equations alive we have to impose alternate relativistic relations. We may notice that the small term E_g has a radical role (although it has comparatively very small quantity) because its presence In the equation realizes the case of $v^2 = c^2$ as additional intrinsic property of the particles inside the sphere as expression of new additional definition of the rest energy of the whole sphere, while eliminating

the equation from this term realizes the state $v^2 \approx c^2$ which represents a dramatic deviation from the first case and needs alternative relativistic solution.

In the first section we will discuss the required conditions which include the density and the physical properties of this proposed sphere. In the second section we will see that this physics succeeds to construct a system. The surprise was that this system has physical properties matching that of our solar system.

The core idea of the paper is built on equating the kinetic energy of each of the above three terms of the above equation with that of Einstein equation like that:
 $k \frac{e^2}{r_o} \left(\frac{r_o p}{r_c n^{\frac{1}{3}}} \right) = k \frac{e^2}{r_o} \times 1 \equiv m_o c^2$ if, and only if the in-between brackets equal one.

Yes, this proposed sphere runs against the current physics because, according to Fermi-Dirac statistics, the particles with energies greater than Fermi energy have zero probability to exist, and also according to special relativity $v = c$ is forbidden, therefor our strategy will be discussion the physics of the sphere regardless these contradictions in the first section of the paper, and then in the section of thermodynamics we will see the probability of finding of this sphere in the primordial universe taking in consideration the above objections.

Discussion

I- If we defined a closed non-conducting sphere S , formed of number of protons p , distributed homogeneously in much more number of neutrons n , and if we equated the quantity $\frac{r_o p}{r_c n^{\frac{1}{3}}}$ with the number one we can get

$$k \frac{e^2}{r_o} \left(\frac{r_o p}{r_c n^{\frac{1}{3}}} \right) \equiv k \frac{e^2}{r_o} \times 1 = E \equiv E_o \equiv m_o c^2 \quad (1)$$

This is a nontrivial solution defines the initial conditions ($m = m_o$ and r_o is the old classic rest radius of the particle while, $r_c n^{\frac{1}{3}}$ is the radius of the system in this bound state.

$$\text{And, } r_c = r + \Delta r \approx \frac{\hbar}{mc} \approx \text{Compton length} \quad (2)$$

We can consider r_c unknown that we have to estimate its accurate value in the bound state.

From the above we can do the next intuitive mathematic operation

$$\frac{1}{2} m_o c^2 \equiv k \frac{e^2}{r_o} \left(\frac{1}{2} \frac{r_o p}{r_c n^{\frac{1}{3}}} \right)$$

That is if (and only if) the in-between brackets equal half.

And then we choose a very small cut of energy ΔE equivalent to the extra Δr of equation 2

$$\Delta E = k \frac{e^2}{r_o} \frac{n}{p \mu} \quad (3)$$

where μ is a new unknown we have to find its value, and

$$\frac{n}{p \mu} \ll 1$$

$$\therefore E_o \approx \frac{1}{2} m_o c^2 \approx \frac{1}{2} k \frac{e^2}{r_o} \left(\frac{r_o p}{r_c n^{\frac{1}{3}}} - \frac{n}{p \mu} \right) \quad (4)$$

Or, we can write it in the form

$$\frac{k e^2}{r_o} \left(\frac{1}{2} \frac{r_o p}{r_c n^{\frac{1}{3}}} - \frac{1}{2} \frac{n}{p \mu} \right) = \frac{1}{2} m_o v^2 \sim \frac{1}{2} m_o c^2 \quad (5)$$

It looks like Coulomb's form of a particle with non-transitional motion: its right side represents the kinetic energy as defined by the forthcoming equation 12, while its left side represents half the electromagnetic energy of each charged particle of the sphere. The particles inside the sphere \mathcal{S} possesses motional property ($v \sim c$) representing the microstates inside the sphere. The above is the first face of the coin, while its second face appears when we insert the approximate relation of equation 5 into the Einstein's equation by adding the positive term (which is equation 3) to appear as the next strict equality

$$\frac{1}{2} k \frac{e^2}{r_o} \left(\frac{r_o p}{r_c n^{\frac{1}{3}}} - \frac{n}{p \mu} \right) + \frac{1}{2} k \frac{e^2}{r_o} \frac{n}{p \mu} \equiv \frac{1}{2} m_o c^2 \quad (6)$$

The speed v in equation 5, appears in the above macro state as intrinsic physical property or (silent) speed; $v = c$

If the free isolated particle was defined by

$$r_o = k \frac{e^2}{m_o c^2}$$

Then the bound one inside the big sphere gets new additional definition $r_c \approx \frac{\hbar}{mc}$ (7)

This gives intrinsic property for the particles:

$$v^2 \approx c^2 \quad (8)$$

If equation 3 equals the gravitational potential

$$u_g = \Delta E = \frac{1}{2} m_o u^2 \text{ where } u \ll c \quad (9)$$

Then, we can rewrite equation (1) as follows

$$\frac{1}{2} m_o c^2 \equiv \left(\frac{1}{2} k \frac{e^2}{r_o} \frac{r_o p}{r_c n^{\frac{1}{3}}} - u_g \right) + u_g \equiv \frac{1}{2} m_o v^2 + \frac{1}{2} m_o u^2 \quad (10)$$

The quantity between the brackets arises only from the spaces between the particles as defined by equations 3, 7 and 8, but when we add the gravitational energy (later on, in equation 21 we will see that this added energy is a positive quantity) we get the whole equation (the macrostate). The quantity u_g inside the brackets is the cut energy mentioned in equations 3, 4 and 5 due to the extra size Δr mentioned in equations 2

All the microstates inside the sphere should be defined finally by the initial conditions of equation 1.

$$m = m_o \quad \& \quad r = r_o \quad \& \quad E = E_o \quad (11)$$

The kinetic energy in our alternative relativistic solution is defined by the initial condition (look at equation 1):

$$\because m = m_o$$

Therefore this enables us to put the mass outside the next integral

$$E_k = \int F \cdot dr = \int m_o \frac{dv}{dt} v dt = m_o \int \frac{dv}{dt} v dt = \frac{1}{2} m_o v^2$$

And from equation 10

$$\frac{1}{2} (m_o v^2 + m_o u^2) = \frac{1}{2} m_o c^2$$

$$v^2 + u^2 = c^2 \quad (12)$$

The free particle loses a bit of its mass to reside in a bound state. Here in our sphere, the particle- like rest energy loses a bit of energy $\Delta E \equiv u_g$. After adding the gravitational kinetic energy $\Delta E = u_g$ we get the general form of equation 1, 10 and 12 (rest energy).

Now, the goal is to realize all the above abstract mathematic equations inside the sphere. That is to prove physically that all the energies: the electric u_e , the 'quantum exclusive' u_c and the gravitational u_g in addition to the energy of the magnetic moment u_s are added as: $(u_e + u_s) + u_g \equiv m_o c^2$.

$$u_c + u_g \equiv m_o c^2$$

If we succeeded to do that then we can say that we realized equation 1, hence we can deal the entire energy of the big sphere as rest energy. So, we can deal the total kinetic energy as summation of zeros (rest energy of the entire sphere). Let us go step by step:

1- The electric field inside the sphere

Let us define

$$\gamma^2 = \frac{1}{1-\beta^2} \equiv c_o \quad (13)$$

where $\beta^2 = \frac{v^2}{c^2}$ and c_o is a new symbol.

$u_e \gg u_g$ while the relativistic electric energy $u_e(v)$ is affected by one γ , while the gravitational $u_g(v)$ is affected by γ^3

$$u_e(v) = k e^2 p \frac{\gamma}{r_s} = m_o c^2 \quad (14)$$

Such that $r_s = r_c n^{\frac{1}{3}}$

$$u_g(v) = -G(m_p n m_n \gamma^2) \frac{\gamma}{r_s} = \frac{1}{2} m_o c^2 \quad (15)$$

So, when $v \approx c$ as in equations 2, 4 and 8, and from equations 14 and 15 we can define $\frac{n}{p}$ to reach the equality

$$u_g(v) = u_e(v) \quad (16)$$

Inside a closed sphere, the Gaussian surface could be applied to the gravitation and electric field, so at any point we have the same equality. If $m_p \approx m_n$ then from equation 13 we can realize the existence of the sphere by equating the electric energy per proton to the gravitational energy per the same proton. We can use the new symbol, of equation 13, in the equality

$$u_e(v) = k e^2 p \frac{c_o^{\frac{1}{2}}}{r_s} = u_g(v) = -G n m_o^2 c_o \frac{c_o^{\frac{1}{2}}}{r_s} \quad (17)$$

This equation represents the microstate inside the sphere and should be bounded by the initial conditions of equations 1 and 11: $r = r_o$ and, $m = m_o$

So, we have to do cancelling for the factor c_o between both sides (and between the numerator and denominator if needed). After cancelling, we can get

$$\frac{1}{2} k \frac{e^2}{r_o} = \frac{1}{2} k e^2 \frac{p}{r_s} = -G(n c_o) \frac{m_o^2}{r_s} = \frac{1}{2} m_o c^2 = u_G(v) \neq u_g(v) \quad (18)$$

(where r_o and r_s are defined in equation 14). You notice the factor $n c_o \equiv n \gamma^2 = N$ appears as alternate relativistic solution and $u_G(v)$ is atypical potential (doesn't take the form $u_g(v)$)

2- The quantum state inside the sphere

On the same way of Fermi sphere we can understand the Compton sphere defined by equations 2 and 7

The particles density is the inverse of infinitesimal volume

$\frac{n}{V}$. The quantum energy density inside the neutron well

$$u_c = \frac{\hbar^2}{2m} \left(\frac{3\pi^2}{V} n \right)^{\frac{2}{3}} = \frac{A}{r_c^2 m_o} \quad [3]$$

where A is a non-arbitrary constant. As we did in equation 17, and respecting the initial conditions we can process the cancelling to the relativistic equation to get

$$u_c(v) = \frac{A c_o^{\frac{1}{2}}}{r_c^2 m_o}$$

Again, as we did in equation 16 and 17, we expect the equality

$$\frac{A}{r_c^2 m_o} = u_c = - \frac{G m_o^2 (n \cdot c_o)}{r_s} = u_G(v) \neq u_g(v)$$

Again the factor $nc_o = \gamma^2 n$ appears as alternate relativistic solution which we will discuss later on.

3- The imaginary and the alternate relativistic solution

You can notice equations 18 and 19 speak about the quantity $\approx \frac{1}{2} m_o c^2$ and not the quantity $= \frac{1}{2} m_o c^2$.

So, we search for a solution realizes a complete (not approximate) equality like:

$$\frac{1}{2} u_e(v) + u_g = \frac{1}{2} m_o c^2$$

$$u_c(v) + u_g = m_o c^2$$

where u_g is the non-relativistic gravitational energy.

Let us apply the imaginary solution

$$\text{At } v^2 = 2c^2 \quad (19)$$

$$\therefore m^2 = \frac{m_o^2}{1 - \frac{v^2}{c^2}}$$

$$m^2 = -m_o^2 \quad (20) \therefore$$

And then insert it in equation 17

$$-Gn \frac{-m_o^2}{r_s} = Gn \frac{m_o^2}{r_s} = \text{positive non-relativistic } u_g \quad (21)$$

You can notice that the negative relativistic quantity $u_G(v)$ of equation 18 (It is not the proper gravitational potential) which carries the alternate relativistic solution is transformed inside equation 21 into positive non relativistic quantity.

This positive energy could be added to u_c and u_e

$$u_c + u_g = 2u_e + u_g = m_o c^2. \quad (22)$$

But, **how is equation 19 realized?**

Each particle inside the sphere has its own rest intrinsic energy $= m_o c^2$ which expresses its own rest radius $r_o = k \frac{e^2}{m_o c^2}$

And here, we add from equation 19 another half

$$(\frac{1}{2} m_o c^2).$$

This additional half expresses the additional space length of equation 2 which is $r_c \approx \frac{\hbar}{mc}$. This new state, as we will show, adds for the charged particle a second half coming from its own magnetic moment (as we will see). So, as a net result, the charged particle obeys

$$m_o c^2 + (\frac{1}{2} m_o c^2 + \frac{1}{2} m_o c^2) = 2m_o c^2 = m_o (2c^2) \quad (23)$$

And the neutron particle obey

$$m_o c^2 + (m_o c^2) = 2m_o c^2 = m_o (2c^2)$$

You notice that the particle does not duplicate its mass, such that the equation realizes equation 19. Equation 22 shows the deep meaning of the alternate relativistic solution of equations 18 and 19 as multiplication of the particles by the factor c_o

It is replication of the rest energies which defined by $r_o = k \frac{e^2}{m_o c^2}$ and $r_c = \frac{\hbar}{mc}$

The operation $nc_o = N$ means replication of the null sets or zeros of energy. The point which we have to stress on well is that the process of multiplication (replication) does not mean true creation of new particles but it means only conquering and grab of the surrounding particles existing outside the sphere into the inside of the sphere (which is coincident with the atypical potential appearing in equation 18). That is to say; it is replication of the rest state ($v^2 = c^2$) of the particles of the sphere while the entire number of the particles of the universe is constant [4]. Equation 23 means addition of rest energies not frank addition of speeds. It gives only the physical description of the negative mass.

The final form is $c_o n = N$ or:

$$\sum_n^N E_o = \sum_n^N m_o c^2 = \sum_n^N \text{zeros} = \frac{N}{n} m_o c^2$$

$E_o = m_o c^2 = f(r_c) = f\left(\frac{\hbar}{m_o c}\right)$. This is equivalent to

$$E_o = f(r_o) = f\left(\frac{ke^2}{m_o c^2}\right) \rightarrow \sum_n^N E_o = \frac{N}{n} m_o c^2$$

The net result is multiplication (replication) of the sphere by the same factor. The above addition occurs only if, and only if, the density is still obeying equations 2 and 7.

Up till now, each proton inside the sphere has

$$\frac{1}{2} u_e(v) + u_g = \frac{1}{2} m_o c^2$$

The Fermi (Compton) energy of the proton is neglected because it only applies for fermions of the same type: that is to say the distance between each two neighbor protons is so long ($p \ll n$) comparative to that of neutrons.

Now we will search for the remainder half. Let us at first study the free particle as defined by $r_o = k \frac{e^2}{m_o c^2} \rightarrow E_o = m_o c^2$

This could be seen as formed of two halves ($2 \frac{1}{2} m_o c^2$)

The electric energy density $u = \frac{1}{2} E^2 \epsilon_o$

$$u_x + u_y + u_z = u = 3 \frac{e^2}{32 \pi^2 a^4 \epsilon_o} \int_0^{2\pi} \int_0^{\pi} \int_0^r r^2 \sin\theta \, dr \, d\theta \, d\varphi$$

$$= \frac{e^2}{8\pi\epsilon_o} = \frac{1}{2} m_o c^2$$

The spin of the particle adds the second half as follows

$$u_s = m \cdot B = (i\pi a^2) \cdot B$$

$$B = \frac{\mu}{4\pi a^2} i \int dl = \frac{\mu i}{2r}$$

$$i = \frac{e}{T} = \frac{ev}{2\pi r} \rightarrow B = \frac{\mu ev}{4\pi a^2}$$

from all above

$$u_s = \frac{e^2}{8\pi\epsilon_o} = \frac{1}{2} m_o c^2 \quad (24)$$

4- The average energy density in our sphere

$$\frac{1}{2} k \frac{e^2}{r_o} \approx \frac{1}{2} k e^2 \frac{p}{r_s} \approx \frac{1}{2} m_o c^2$$

$$u_c = \frac{\hbar^2}{2m} \left(\frac{3\pi^2}{V} n \right)^{\frac{2}{3}} \approx m_o c^2$$

And, from equation 18 we have

$$-\frac{G m_o^2 (n, c_o)}{r_s} = u_G(v) = \frac{1}{2} m_o v^2 \approx \frac{1}{2} m_o c^2$$

Which appears in the imaginary solution as positive u_g could be added to u_c and u_e (equation 22).

$$\int_0^n u_c dn = \frac{\hbar^2}{2m} \left(\frac{3\pi^2}{v}\right)^{\frac{2}{3}} n^{\frac{2}{3}} dn = \frac{3}{5} u_c n$$

$$u_a = \frac{3}{5} u_c = \frac{3}{5} \frac{\hbar^2}{2m} \left(\frac{3\pi^2}{V}\right)^{\frac{2}{3}} n^{\frac{2}{3}} = m_o c^2 \quad (25)$$

And the average electric energy becomes

$$\frac{3}{5} k \frac{e^2}{r_o} \left(\frac{r_o p}{r_c n^{\frac{1}{3}}}\right) \equiv \frac{3}{5} k \frac{e^2}{r_o} \times 1 = E \equiv E_o \equiv m_o c^2 \quad (26)$$

And the negative quantity (not properly gravitational binding energy) takes the form

$$-\frac{3}{5} \frac{G m_o^2 (n.c_o)}{r_c n^{\frac{1}{3}}} = -\frac{3}{5} \frac{G m_o^2 (N)}{r_c n^{\frac{1}{3}}} = u_G(v) \approx \frac{1}{2} m_o c^2 \neq u_g(v) \quad (27)$$

5- Definition of the giant proton:

$$\therefore u_c = \frac{3}{5} \frac{\hbar^2}{2m} \left(\frac{3\pi^2}{V}\right)^{\frac{2}{3}} n^{\frac{2}{3}} = mc^2$$

$$\therefore r_c = 2.2 \times 10^{-16} m \quad (28)$$

In the next section we will show:

$$N = 2.6 \times 10^{45}$$

Therefore, inserting the value of r (from equation 28) onto equation 27, and putting $nc_o = N$ enable us to have one unknown so, we can estimate: $n = 5.8 \times 10^{21}$

And then from equation 26 we can get

$$p = 4.4 \times 10^9 \text{ Proton.}$$

And then from the quantity N , we can define:

$$c_o = 4.5 \times 10^{23}$$

$$\mu = 5.8 \times 10^{35}$$

$$v^2 = c^2 \left(1 - \frac{1}{4.5 \times 10^{23}}\right) \approx c^2$$

$$u_g = 1.6 \times 10^{-34} \text{ joule} \quad (29)$$

The above is estimated from equation (28). Inserting in Newton law the value $n = 5.8 \times 10^{21}$

$$\therefore u^2 \approx 2 \times 10^{-7}$$

$$\frac{n}{p} = 1.3 \times 10^{12}$$

It is useful to notice the physical meaning of equation 12 from the relation $\gamma^2 =$

$$\frac{1}{1 - \frac{c^2 - u^2}{c^2}} = \frac{c^2}{u^2}$$

Summary and results of the above sections:

$$\frac{3}{5}(u_e + u_s + u_g) = m_o c^2 \equiv k \frac{e^2}{r_o} \times 1$$

$$\frac{3}{5}(u_c + u_g) = m_o c^2 \equiv k \frac{e^2}{r_o} \times 1$$

$$\frac{3}{5}u_g = \frac{1}{2}mu^2$$

And, its relativistic quantity (only inside the equations of the paired microstates, like equation 18) obeys

$$-\frac{3}{5} \frac{G m_o^2 (n.c_o)}{r_c n^{\frac{1}{3}}} = u_G(v) \approx \frac{1}{2} m_o c^2 \neq u_g(v) \quad \text{which reveals the **alternate** relativistic solution } (n.c_o) = N$$

Or, written (only inside the equation of the imaginary solution) in its positive form

$$-\frac{3}{5} \frac{G m_o^2 (n\gamma^2)}{r_c n^{\frac{1}{3}}} = \frac{3}{5} \frac{G m_o^2 n}{r_c n^{\frac{1}{3}}} = \frac{1}{2} mu^2$$

II- Physics of the giant atom [4]:

$$\therefore m_p \approx 1840m_e$$

$$\therefore ke^2 \frac{p}{r_s} = -G(nc_o) \frac{m_o^2}{r_s} = \frac{1}{2} m_o c^2$$

$$\therefore (u_g)_e = \frac{1}{1840} (u_g)_p = m_e c^2$$

$$\frac{N_e}{N_p} = 1840$$

The above means that the giant electron mass = 1840 times the giant proton mass (because the first needs number of neutrons 1840 times that of the second). Hence, the second would rotate around the first. This inverted atom is not a physical step in creation of the giant atom; it is just a mathematical imagination to understand how physics of the giant atom works.

The giant proton to orbit as a whole (one body) its particles have to be tied well with its sphere otherwise, the protons will depart its sphere and orbit as a singled-particles like rosary beads

$$\therefore G \frac{m^2}{r} N \frac{N}{P} \gtrsim \frac{1}{2} m \frac{N}{P} v_o^2 \gtrsim \frac{1}{2} k \frac{e^2}{R} P \quad (30)$$

where v_o is the speed of the first orbit which equals the escape velocity of an orbiting object.

But, there is still a hidden factor, let us search for.

Suppose we have two cases. The first is a giant proton orbits as one body, and the second case is that its orbital is arranged one by one as rosary beads. To prevent 'case one' from breaking up, we need a further factor. The next discussion may reveal this factor. The stored energy E_s in a capacitor (charging one by one)

$$E_s = \int_0^q \frac{q}{c} dq = \frac{1}{2} Vq$$

There is a lost electric energy (in resistance as heat), and we have only half the quantity. Inserting this factor in equation 30 then the condition is

$$G \frac{m}{r} N(m \frac{N}{P}) \gtrsim \frac{1}{4} (m \frac{N}{P}) v_o^2 \gtrsim \frac{1}{4} k \frac{e^2}{R} P \quad (31)$$

We need only the critical value or the least possible energy $G \frac{m^2}{r} N \frac{N}{P}$ therefore we used the symbol

(\approx) in the above equations. This symbol is physically meaningful. It enables us to estimate the orbital radius of the giant proton (which orbits as one body) from the equation in which the orbital looks as rosary beads like:

$$2\pi R = (\lambda \frac{P}{N})P \quad (32)$$

Where λ is equivalent to the wave length of the hydrogen atom [5], while in the giant atom, the in-between brackets is representing the wave length of one proton weighted by $\frac{P}{N}$ (this means that the giant atom orbital length equals its wave length $\lambda \frac{P}{N}$ times number of protons). Hence, the wave length of the giant atom is very small and narrow, so that the probability of finding the particle looks as

$$\psi_i^2 = \begin{cases} 1 & i = \lambda \frac{P}{N} \\ 0 & i \neq \lambda \frac{P}{N} \end{cases}$$

The above orbital form does not mean that our orbital looks as rosary beads. It only means that the first orbital just needs the critical form of equation 31 to avoid the rosary beads form, but mathematically we can use equation 32 to define the orbital radius. Now to define the orbital ground speed we have to go further in the depth of the physics of the hydrogen atom.

Recalling that the interior of the energies of the giant charge is zero, and considering that we need to understand the mathematic bases of the orbital of the giant atom, we can imagine the inverted hydrogen atom which has no existence absolutely. It only acts inside the giant atom. Suppose we want to play in the physics of the hydrogen atom, and forget for a moment the quantum mechanics. We will do nothing: we will keep the relative motions, electrostatic force, kinetic and potential energies, and all the other Newtonian laws without changes. All what we do is that we imagine the electron got a mass 1840 as massive as the proton mass. Recalling this extreme difference between the mass of this new electron and the mass of the proton, and recalling the two-body problem, and because we did not introduce any new charge therefore, all what occurs is exchange the mass center of the system to be nearer to the massive body which, here, is this new electron. For simplification let us make our origin coincident with the new mass center, and let the total mass

$$M = m_p + m_e \approx m_e$$

$$r_p = m_e \frac{r}{M} \text{ and } r_e = m_p \frac{r}{M}$$

$$k \frac{e^2}{r^2} = \frac{m_p v_p^2}{r} = \frac{m_e v_e^2}{r}$$

From above we can conclude that this new atom has the same old radius but the massive electron and the old proton exchanged their positions relative to the center of mass of this inverted atom. Classically, we can conclude:

$$r_p = r_{Bohr} \text{ and } v_p = 5 \times 10^4 m/s [5]$$

And substituting in equation 31

$$\therefore N = 2.6 \times 10^{45} . \quad (33)$$

In equations 31 and 32 you notice new form appears as $\frac{N}{p}$ for each proton. This could be called 'huge proton' which is the unit of the giant orbit. Basically, we have two microstates for each macro state ($\pm \frac{1}{2} spin$). In Compton gas (Fermi), the orbit is formed of number of protons (= number of the macro states = twice the number of the microstates p) times' the wavelength of the huge proton.

Equation 31 takes the shape of the least gravitational potential (inside the giant proton) required to prevent the gradual escape of the outer most layer (the work done to move a particle from the outermost layer to a reference outside the sphere is the least, comparative to the deeper layers). From the definition of the giant proton

$$\therefore P = pc_o = 1.9 \times 10^{33}$$

From equation 32, we estimate the orbital radius

$$R = 7 \times 10^{10} m. \text{ And from}$$

$$m \frac{N}{p} v_o^2 = k \frac{e^2}{R} P \text{ we can ensure the same result. And from above:}$$

$$v_o = 5 \times 10^4 m \text{ per second} \quad (34)$$

$$R = 7 \times 10^{10} m \quad (35)$$

These match v and R of Mercury planet.

From definition of the giant proton and giant electron:

the sun mass M_s relative to the mass of all the planets combined $\sum M_p$ obeys

$$\frac{M_s}{\sum M_p} = 1840$$

From the present physical values of the solar system; sun mass is about $2 \times 10^{30} kg = 700$ times as massive as the mass of all the planets combined [6].

Jupiter: the massive planet in the solar system was born small, with mass about one over fifteen from its present mass, then it reached gradually to its present mass after millions of years [6].

Taking this old mass of Jupiter in our estimation, we can estimate the present ratio

$$\frac{M_s}{\sum M_p} = 700. \quad (36)$$

This matches the observed mass ratio. We can rewrite equation 31 in the next form

$$G \frac{m}{r} N(m \frac{N}{P}) \approx \frac{1}{4} (m \frac{N}{P}) (v_o^2 + d^2) = \frac{1}{4} k \frac{e^2}{R \cdot d^2} P$$

So, we can define complicated giant proton with higher orbitals to match the physical properties of the higher planets. The above new factor is a positive natural or rational number lies between 1 and 10.

III- The fate of the giant atom

Can we approach two or more of similar giant charges?

No, we cannot. Although the field inside each one alone is zero, yet it is so great between two or more. Displacing two spheres similar in the charge to collect together with the same density needs infinite work.

Go to fire! Actually, this is a bad surprise, but the matter to us here is that; the giant atom drew the physical properties of the orbitals. So in the next two sections we may see a good surprise.

IV- Thermodynamics of the giant atom

From the previous chapters; the net kinetic energy inside the giant proton equals the zero electric plus the zero quantum energy plus the gravitational kinetic energy. Inserting equation 28, and then putting $N \approx 3 \times 10^{45}$ Therefore, the net energy equals

$$u_g(N) = \sum_n^N 0 + G \frac{3}{5} \frac{m \cdot N}{r} m \approx 10^{-5} MeV \quad (37)$$

Henceforth, this quantity will prevail and achieve the radical role in understanding the mechanism of creating the giant atom. Therefore, we have to differentiate between the above quantity and the quantity defined by equation (29), where the relation between both is defined by $N = nc_o$, such that, c_o is the replicating factor which arises from the alternative relativistic solution. Solving the problems of the giant atom (how can we explain its density? And from what the quantity $N = nc_o$ was originated?) needs to understand the following: Because all the interior of the giant charge are zeros and it have not any definition except the value which appears in equation (37) so, let us label each particle inside this sphere by this quantity, and let us rewrite the equation in the form

$$u_g(N) = \sum_n^N 0 + G \frac{3}{5} \frac{m \cdot nc_o}{r} m \approx 10^{-5} MeV$$

Labeling the particle with this quantity is the macroscopic outcome for the microscopic events which had been mentioned in section one. Now I will use the Boltzmann chemical potential distribution function to define the number density of the labeled neutron compared to that of the free neutrons. Now let us at first, remember the next information's:

At time of freeze out ($\approx 0.7 MeV$) in the early universe, as in the Standard model, the ratio $\frac{n}{p} = e^{-\frac{\Delta mc^2}{kT}} \approx \frac{1}{6}$

The binding energy of Deuterium $B_D \approx 2.2 MeV$.

$$\eta = \frac{n_b}{n_p} \approx 5 \times 10^{-10} [7]$$

The peak of synthesis of deuterium (at $t \approx 2 \text{ minute}$ of BB)

$$u_D = \frac{B_D}{-\ln \eta} \approx 0.1 \text{ MeV} [8] \quad (38)$$

At that time; there was sudden burst of deuterium synthesis and rapid consumption of the free neutrons. The curve grows rapidly at 2 minute. After 3 minutes the rate became roughly constant [Hou et al 2017].

Now, we will search for the suitable time in the early universe which enables $u_g(N)$ to survive. Because it is small (10 eV) so, the universe should be cold enough to its probable existence otherwise it would be destroyed completely by the energetic photons. But also it should be hot enough to precede the peak rate of deuterium synthesis otherwise the giant charge would not find enough considerable amount of free neutrons. This means that the suitable time to discuss probability of finding the giant protons is roughly at 0.1 MeV

From all above; the number of the particles in a defined phase (giant protons) relative to the number of the particles of the medium (universe) equals the probability to find number of particles with 10^{-5} MeV among $T = 0.1 \text{ MeV}$

Let me use the distribution function using the symbol l as an expression for the mass of the labeled bound particle inside the sphere, and the symbol f for the mass of the free neutron outside it. Since, the bound particle has potential while the free one doesn't have so

$l < f \rightarrow -l > -f$ Therefore, we can write

$$f(l) = \left(\frac{l}{f}\right)^{\frac{3}{2}} e^{\frac{f-l}{T}} \eta \quad (39)$$

Putting $\eta \approx 10^{-9}$

$$\therefore \frac{n_l}{n_f} = 10^{-9} e^{\frac{10^{-5}}{0.1}} \approx 10^{-9} \quad (40)$$

But, we have to search for the mass between the bound particles inside the sphere which is missed here while it appeared in the first section in the form of $m_o c^2$ as in equation (23). I can suggest the next reaction:

One free particle plus another free one produces one bound labeled particle plus potential energy, therefore we can rewrite: By the thermal collision: $(n + n)_f = (n)_l + 10^{-5} MeV$. And from section 1, we can understand that the labeled particle is weighted as; $m_o 2c^2 \equiv 2m_o c^2$. This equation goes strait forwarded with the final result of equation (39) because we still can write the difference of the masses in joule, in the reaction inside equation (40), in the form: $f - l = 10^{-5} MeV$. Moreover, since that the difference in mass between the labeled particle and the particle of deuterium equals $m_l - m_D = l - D = 2.2 MeV$ therefore the number density of the labeled particles to that of Deuterium:

$$f(l) = \frac{n_l}{n_D} \approx e^{\frac{-l+D}{T}} \approx e^{\frac{D-l}{T}} = e^{-22} \approx 10^{-9}$$

It appears now that the microscopic income (the extreme speed) which appeared in the first section isn't more than a macroscopic replication outcome (as in equations 1 and 27). And this replication is actually not more than introducing excess free particles from the surrounding into a new state inside our sphere so that the entire number of the particles of the whole universe is the same without change. Because the net energy of the particle = $u_g \approx 10^{-5} MeV$ is a function in N and r of the sphere so, this density function gives here, description for the sphere-bound particles and a description of the whole sphere. The function defines the probable ratio of the number of all the particles of all the spheres (of the proposed solar -like systems) combined, to all the number of all the particle of the entire observed universe. Also, we notice that this equation (40) cooperates with the alternate relativistic equations (18 and 27) to discover the physical origin of the factor c_o (defined by equation 29) which is incorporated implicitly in equation of the orbital motion (31). I can simplify the concept of our paper as: Since it is impossible to arrive to speed of light then let us ask about the cause. If the cause was that it needs extreme energy then let us ask about energy. If it is equivalent to matter then let us ask about matter. If it is particles then let us use particles to arrive to the extreme speed. If we cannot do but the old universe did then let us read the written by the universe. It looks for me that God had created the macroscopic outcome and left us to read the underline microscopic events.

Nevertheless $KT \gg u_g$, however the 'authority' of the probability function guarantees abundance of good number of the spheres (as we will see). From the definition of the giant proton the number N of the particles inside the giant proton $\approx 3 \times 10^{45}$ and the

number of the particles in the seen universe $\approx 10^{80}$ [9]

From above, and from equation 40, the expected number of the giant protons in the early universe $\approx \frac{10^{80}}{3 \times 10^{45} \times 10^9} \approx 3 \times 10^{25}$ (41)

V- Physics of the primordial solar system

In the first two sections we defined the gravitational binding energy of the giant electron B_e and also we defined the giant atomic orbitals (system) which have orbital binding energy $E_O = E_p - E_k \equiv \frac{1}{2}mv^2$

From equation 31 and 37 we can derive that the gravitational binding energy u_g of the giant proton $u_g = \frac{1}{2} E_O \approx \frac{1}{2} B_e \approx 10^{-5} MeV$
(1840)²

From the first section we can imagine a giant neutron; using the same alternate relativistic solution till we reach to equation 33 and 37, and then we define its distribution function. So, the giant neutron is a giant proton but without charges. Moreover, by the aid of statistics we can define the probability of finding of the orbital of a giant "neutral" atom fixed on the same orbital of the giant atom (like equations 34, 35 and 36). This is the suggested primordial -solar model: it is formed of mini-solar systems. Each system is formed of a giant neutron A , orbiting another one B . The central one is 1840 times as massive as the orbiting one. Then we have different levels (for the different planets) according to the factor d . So, simulating to equation 31, we can write

$$G \frac{m}{r} nm \gtrsim \frac{1}{4} (mn)(v_o^2 \div d^2) = \frac{1}{4} G \frac{m.N}{R.d^2} m \quad (42)$$

Here, N is the number of the particles of the central sphere of one unit, while n is the number of the particles of the orbiting one. We suggest also that the summation of A , equals the summation of B . By the gravitational attraction union occurs, and hence forth, Newtonian equations can explain the orbital motion.

But what is the magnitude of the orbital speed here? We can find the answer in equation 31 which summited a principle stating that the kinetic energy of each orbiting particle must be equal or less than the gravitational binding energy. Although equation 31 talks about the giant atom, while here instead, we speak about neutral sphere yet, the above principle prevails also here. Since the gravitational energy per particle inside the orbiting charged or neutral sphere is the same in magnitude (because both have the same density and number of particles) therefore, from equations (30) and (34) and putting the radius of the orbit of the **neutral** giant atom equal R_n while that of the giant atom of equation (30) equal R .

$$G \left(\frac{mN}{r} \right) = \frac{1}{4} v_o^2 = \frac{1}{4} \times (5 \times 10^4)^2 = G \frac{mN}{R_n}$$

$$\therefore R_n \approx 0.5 m \ll R$$

This small orbit length was suitable for the old dense small universe. Now, considering the subscripts i for the initial mini system and no subscript for the final form after the collection Σ :

$$v_o^2 = G \Sigma \frac{M_i}{R_i} = G \frac{M}{R} = v^2 \quad (43)$$

This is the simple equation controlling the planet motion (the right equality), but with the hidden hereditary giant atom physics (the left one).

Actually, the big sphere had created thermally, such that it was pregnant and carrying the units of small spheres with homogeneous density. So, we can speak about primordial thermal creation of the big sphere, but we cannot do that for the small one alone. Why? Because first, you notice that we defined -in the first section- the small sphere by using the value of N of the big sphere (as defined in the second section). Second, u_g of the small sphere is hidden inside the zero energy (as equation 22), while in the big sphere we notice that its binding energy appears by adding non-zero term as in the next function

$\Sigma_n^N 0 + f \left(\frac{N}{n} \right)^{\frac{2}{3}} \approx 10^{-5} MeV$ (equation 37). By this meaning we have to understand the alternate relativistic solution of equations 25 and 27 on the light of the genius thermodynamic equation 40. Since all the equations (the alternate relativistic and the thermodynamics) speak about the big sphere, then, to complete our success we have to find the physical tools to approach many of

these giant atoms and collect them together. But collecting positive (or negative) spheres needs infinite work have to be done. Hence, the theory collapses. This made us adopt the same theory but with neutral big spheres.

VI- Thermo statistics of the solar systems

Now, the sun has about 10^{57} *particle* and consequently, all the planets (of our solar system) have about 10^{54} *particle*. So that, they had number of giant neutrons (in the early universe) $\approx \frac{10^{54}}{3 \times 10^{45}} \approx 3 \times 10^8$.

Inserting equation 41, we expect

Solar-like system in the universe had been created as in our $\frac{3 \times 10^{25}}{3 \times 10^8} \approx 10^{17}$ model. (44)

VII- Elements abundance in our model:

BBN results in mass abundance about seventy five percent hydrogen and the reminder as helium. At the universe temperature was 0.7 Mev the proton neutron ratio was $6 : 1$ but few minutes later, by decay of neutrons, it became $7 : 1$. Our model agrees with all above. It speaks only about very small zones of the early universe occupied by the giant neutrons. Inside our sphere, the neutron proton ratio inside our sphere was roughly **one to zero**. The neutrons were two minutes old, and have to decay because they have average life time about fifteen minute. $N = N_0 e^{\frac{-t}{\tau}} \approx N_0 e^{\frac{-2}{15}} \approx 0.87$

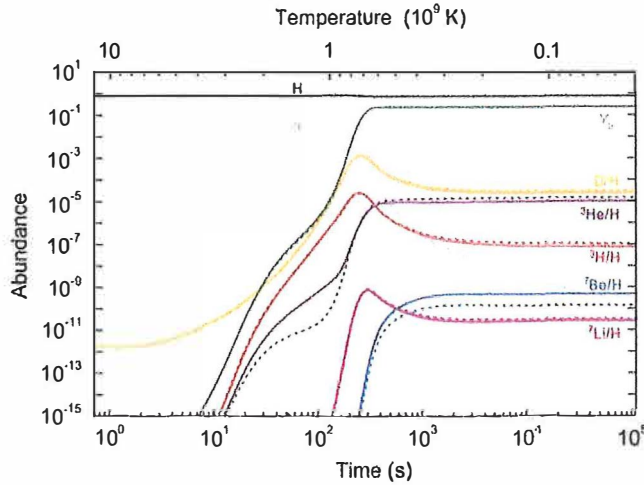
$$\begin{array}{ccc}
 n & : & p \\
 \downarrow & & \downarrow \\
 87 & : & 13 \\
 \downarrow & & \downarrow \\
 75 \text{ } n + 6 \text{ pairs} & : & 6 \text{ pairs}
 \end{array}$$

These six pairs (percent) fuse to form about twenty-five percent mass abundance of helium. By time pass, the temperature falls enough to prevent further considerable fusion, but of course would not prevent neutron to decay. So, the remainder seventy five, by time and by neutron decay, would construct seventy

five percent mass abundance of hydrogen (you notice my alternative mechanism which gives results matching the observed values. But, what is the age of the newly born neutrons of the big sphere? We showed that the small sphere ($n \approx 10^{21}$) gave by alternate relativistic solution ARS the big sphere ($N \approx 10^{45}$) at time 2 minute after BB. Was its age at this time two or zero minute? The answer is two minutes, because ARS does not add extra particles. It just means cutting up a big zone from the universe to represent the big sphere of the giant charge. The small one has no existence outside the big sphere but its mathematics is acting inside it. The big sphere did not come after the small one, but both came at the same moment. ARS does not mean more than it is the solution which enables us to equate $\sum_n^N \text{zeros} = \frac{N}{n} m_o c^2$

Summary:

We can put the next as tests for success of our theory: equations 34, and 35 to match the planetary orbitals, and equation 36 and 43 to match the mass of the Sun and its planets. The abundance of the light elements in the universe is another matching. I hope this paper to help the scientists -in the future- to succeed in storing extreme energy. It looks that Allah had written the macroscopic outcome and left us to read the microscopic income of the events.



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Conclusion

The famous Einstein's equation ($E_o = m_o c^2$) can describe the rest energy of a particle; similarly, I submitted the same equation to describe a closed sphere, filled with particles. Hence, we put all the energies inside the sphere which contains this bound state of the particles in a rest state. Hence, we can add these rest energies of the particles as summation of zeros. This led me to submit for physics of the relativistic giant atom.

This giant atom was created in the early universe. We defined its time of existence after BB, as well as its life time. After that, the orbitals of these giant atoms were maintained by gravity. The old existence of these giant atoms left its cosmological implications in the orbital radii and velocities of the planets of the solar system. Our model succeeded to put explanation for the light elements abundance matching the standard model.

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THOUGHTS ON THE EXISTENCE OF AN AETHER

Jeremy Dunning-Davies

Department of Mathematics and Physics (retd)
University of Hull, England
Institute for Basic Research
Palm Harbor, FL USA
masjd@masjd.karoo.co.uk

Rich Norman

Scientific Advisor, Hadronic Technologies Inc.
Editor, Journal of Unconscious Psychology
editor@thejournalofunconsciouspsychology.com

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Abstract

Several neglected papers from the last century are resurrected and their contents analysed in order to revisit the question of whether or not there is an aether. The results of that query lead to suggesting possible new approaches to many fundamental ideas in physics. Negative energy and the primacy of thermodynamics in universal processes are discussed. Practical benefits of including an aether within a functional physical paradigm are discussed, inclusive of new methods of clean energy production and the rapid disposal of nuclear waste according to hadronic physics.

Introduction.

To many, the question of the existence, or otherwise, of an aether had been settled seemingly once and for all with the emergence of Einstein's theory of special relativity. However, the habits of a lifetime die hard and its possible existence was still a view harboured by many. It was against this background that Kenneth Thornhill produced two important, but sadly neglected, articles in 1983^{1,2}. The introduction to the first of these gives an excellent background to the arguments around at the time and indicates his approach to the problem. In it he says:-

“The question, whether or not there is a physical ethereal medium in which electromagnetic waves propagate, has been asked for many centuries. On the one hand, there have always been those who have maintained that it is not a sensible question to ask, since radiation is observed to have many physical properties and cannot, therefore, exist in a true vacuum or void which is, by definition, the total absence of anything physical. On the other hand, for about the last hundred years, it has come to be largely accepted that there is no physical ethereal medium, and the physical properties of radiation have been transmogrified into waves, and energy parcels or photons, in a space-time metric.

The arguments for the denial of a physical ethereal medium are manifold (see, for example, Whittaker³). One of these asserts that Maxwell's equations show that electromagnetic waves are transverse and that, therefore, any ethereal medium must behave like an elastic solid. This argument is invalid, since Maxwell's equations only show that the oscillating electric and magnetic fields are transverse to the direction of wave propagation, and can say nothing whatsoever about any condensational oscillations of any possible physical medium in which the waves are propagating. In fact, the deduction, from Maxwell's equations, that electromagnetic waves are entirely transverse, is no more than a restatement of an assumption that there is no physical ethereal medium. On the

contrary, if there is such a medium, one would deduce from Maxwell's equations, since electric field, magnetic field and motion are mutually perpendicular for plane waves, that its condensational oscillations are longitudinal, in exact analogy with sound waves in a fluid.

Another argument against the existence of a physical ethereal medium is that Planck's empirical formula, for the energy distribution in a black-body radiation field, cannot be derived from the kinetic theory of a gas with Maxwellian statistics. Indeed, it is well-known that kinetic theory and Maxwellian statistics lead to an energy distribution which is a sum of Wien-type distributions, for a gas mixture with any number of different kinds of atoms or molecules. But this only establishes the impossibility of so deriving Planck's distribution for a gas with a finite variety of atoms or molecules. To assert the complete impossibility of so deriving Planck's distribution it is essential to eliminate the case of a gas with an infinite variety of atoms or molecules, i.e. infinite in a mathematical sense, but physically, in practice, a very large variety. The burden of the present paper is to show that this possibility cannot be eliminated, but rather that it permits a far simpler derivation of Planck's energy distribution than has been given anywhere heretofore."

He undoubtedly achieves what he sets out to do in this paper and so removes one of the main objections to the existence of an aether. In the second, he attempts – seemingly successfully – to resolve the second problem he cites concerning the existence of an aether. In the introduction to that article, he outlines succinctly the argument to be employed in what follows:-

"It has been shown¹ that Planck's energy distribution for black-body radiation can be derived for an ethereal medium which behaves as an ideal gas with Maxwellian statistics. Electromagnetic waves may propagate in such an ether, and the oscillating electric and magnetic

fields in such waves are observed to be transverse to the direction of wave propagation. On the other hand, electric field, magnetic field and motion are generally observed to be mutually perpendicular and coexistent, and this suggests that such waves must also comprise longitudinal oscillations in pressure and density. Thus, such waves would not merely have the duality of being electromagnetic, but rather the triality of being electromagnetic-condensational waves, and their condensational aspect would be analogous to that of sound waves in a material gas.

To justify such a concept of the ether, it is, therefore, necessary to establish such a triality of electromagnetic-condensational waves, by showing that all three aspects of the waves propagate together contemporaneously along precisely the same wave-fronts. In general, for three space-variables and time, the wave fronts are given by the characteristic hypersurfaces of the partial differential equations which govern the electric and magnetic field strengths and the motion of such an ether. All such hypersurfaces which pass through a given point in space-time have an envelope, the characteristic hyperconoid through the point.

It is the purpose here to derive the characteristic hyperconoid both for the equations of electricity and magnetism in a gas-like ether, and for the general equations governing the unsteady motion of a gas in three space-variables, and thus to show that they are, in fact, identical. Such a concept of the ether entails no transformation difficulties. For the equations of electricity and magnetism in a gas-like ether, the general equations of unsteady motion of a gas, and their common characteristic hyperconoid, are all invariant under Galilean transformation. Moreover, with such a concept of the ether, there is no dichotomy between the observed wave and particle properties of radiation, for these are essentially no different from the wave and particle properties of sound in a material gas.”

There can be no doubt that Thornhill achieves his aim in this second paper too. However, has he succeeded in proving the existence of an aether? Many would argue in the negative but, again, to many the argument is still open or resolved in favour of an aether. The purpose of this note is to link Thornhill's neglected work with the recent renovation of the quaternion form of Maxwell's electromagnetic equations as, in this approach, not only are there electric and magnetic fields present but also a scalar field which, by its very nature, can accommodate the required longitudinal oscillations to which Thornhill refers.

A review of more recent relevant work.

The above resume of Thornhill's work would seem to indicate that he had advanced a possible solution to the age-old question concerning the existence of an aether. However, one question does seem to remain and that concerns the fact that the accepted form of Maxwell's electromagnetic equations do not show any presence of the longitudinal wave introduced quite logically into Thornhill's investigations. Following the work of Jack⁴, though, it is seen that, if the quaternion form of Maxwell's equations is considered, a new factor is introduced into the theory. In this formulation, the Maxwell electromagnetic equations become

$$\nabla \times \mathbf{B} = \frac{1}{c} \frac{\partial \mathbf{E}}{\partial t} + \nabla T$$

$$\nabla \times \mathbf{E} = -\frac{1}{c} \frac{\partial \mathbf{B}}{\partial t}$$

$$\nabla \cdot \mathbf{E} = +\frac{1}{c} \frac{\partial T}{\partial t}$$

$$\nabla \cdot \mathbf{B} = 0$$

Here all the symbols retain their usual physical meanings but the T , which is the addition as compared with the normally accepted form, represents an extra temporal field and, as indicated, is a scalar field. However, it is apparent immediately that, if this T field is independent of both position and time, the above equations revert to the usual form of the Maxwell equations familiar to all. Nevertheless, in this special case, all that is assumed is that

the T field is constant in time and space, not that it does not exist. Hence, these equations indicate the existence of another, albeit scalar, field associated with the model used to derive the well-known and successfully used Maxwell electromagnetic equations. Exactly the same conclusions follow if the equations are modified to include the terms concerned with the charge density, $4\pi\rho$, and current density, $4\pi\mathbf{j}/c$, in their normal places in the equations.

As has been shown previously⁵, the normal form of the Maxwell equations yields a scalar wave even in the case of zero electric and magnetic fields and this wave possesses a superluminal speed. It seems that, although Thornhill achieved all he appeared to set out to achieve, this work utilising quaternions as a starting point seems to offer support to the conclusions he reached or, in other words, seems to offer support for the idea of the existence of an aether. At this juncture, it might be remembered also that, although Einstein's theory of special relativity did away with the need for an aether, earlier theories did not; that is, you can have relativistic theories which retain the idea of an aether. Also, if one draws on ideas of general relativity for further support for the abolition of an aether, it must be noted that all the reported tests in support of that theory have been explained without recourse to general relativity. Indeed, even as early as 1925, Temple⁶ raised serious qualms about the need for this widely accepted theory.

However, Jack⁴ first linked this new T field, quite sensibly and logically, with heat. He also noted that, in the above equations, the terms involving T could be identified as follows:

$$\nabla \times B_T = \nabla T \text{ and } \nabla \cdot E_T = \frac{1}{c} \frac{\partial T}{\partial t}$$

and, if such an identification is inserted into the above equations, they again assume the form normally associated with Maxwell's electromagnetic equations. Hence, just as is the case when T is assumed constant, the influence of the T field is masked within the basic theoretical structure. Jack⁴ then proceeded to consider, with some success, several processes normally thought to be the preserve of traditional irreversible thermodynamics. In this, he followed the lead of Bridgman⁷ who built an acceptable theory to deal with many such processes via classical thermodynamics. Bridgman did this prior to Onsager's elegant treatment for

irreversible thermodynamics but an elegant treatment which depended, and depends to this day, on the assumption of microscopic reversibility. As Bridgman pointed out, this assumption does not necessarily apply in all genuine physical cases which might need to be examined. In his treatment, Bridgman introduces a second electro-motive force and refers to the two emf's as a 'driving' emf and a 'working' emf. Jack speculates on whether or not his two emf's correspond to these but, considering his linking up of the T field with heat, one wonders if the second emf Jack introduces should be referred to as a T.M.F. or thermo-motive force such as Bridgman considers later in his book? This would seem to make sense but still leaves the question of what the T field is physically? The above appears at first sight to offer two alternative answers. Firstly, Thornhill links it with the longitudinal oscillations of the aether; that is, with motion. However, Jack links it with heat. A possible reconciliation of these two seemingly separate ideas might be offered by way of the Ettingshausen effect where a current applied along (say) the y-axis and a perpendicular magnetic field along (say) the z-axis result in a temperature gradient along the x-axis. This is due to the Hall effect leading to electrons being forced to move perpendicular to the applied current and this, in turn, leads to an accumulation of electrons on one side of a sample which causes the number of collisions to increase and, hence, heating of the material occurs.

The T field is, as has been seen, a scalar field and can transmit scalar, or longitudinal, waves. This is precisely where this theory of Jack links up with the work of Thornhill. As Thornhill points out so lucidly, "the duality between the oscillating electric and magnetic fields, which are transverse to the direction of propagation of electromagnetic waves, becomes a triality with the longitudinal oscillations of motion of the ether, if electric field, magnetic field and motion are coexistent and mutually perpendicular." As stated earlier, it seems Thornhill did succeed in proving exactly what he set out to establish and his end conclusion was in support of the notion of the existence of an aether. It seems that this work of Jack, based on the quaternion form of Maxwell's electromagnetic equations may be seen to

support this conclusion, especially when considered in parallel with other deductions from those quaternion equations⁵.

The Contribution of Whittaker.

All the above links in extremely well with the important, though little known, work of E. T. Whittaker⁸. In this cited paper from 1903 on the partial differential equations of mathematical physics, it is displayed quite clearly in the final section that gravitation and electrostatic attraction may be explained as modes of wave disturbance. It is this final development that links in so successfully with the ideas, due to Thornhill, discussed earlier. It is, incidentally, interesting to note the emergence of the notion of 'gravity waves' coming from a totally Newtonian background theory. However, from the present point of view, it must be noted that Whittaker's theoretical results link up extremely well with Thornhill's idea that the duality of the electric and magnetic waves becomes a triality when you include the scalar – or longitudinal – waves associated with the motion of the electromagnetic wave-front.

One may wonder why this work of Whittaker – a highly respected mathematician- has seemingly lain neglected by so many for so long but possibly the answer lies in the fact that, towards the end of the cited work, he concentrates on gravitational applications and only mentions electrostatic ones in passing. His advocacy of an undulatory theory of gravity would have required gravity being propagated with a finite velocity but one which need not equal that of light and could be much greater. He did not attempt to offer any cause for gravity but merely to show that in order to account for the propagation across space of forces which vary as the inverse square of distance, it is only necessary to suppose the medium capable of transmitting, with a definite though large velocity, simple periodic undulatory disturbances, similar to those whose propagation by the medium constitutes the transmission of light according to electromagnetic theory. Of course, this all presupposes the existence of a said medium and shortly after the appearance of Whittaker's work, the physics community embraced Einstein's special relativity with its lack of an aether or, in other words, lack

of any such medium. The question now arises of whether, or not, this move was really justified and also raises the prospect of physics having been hampered ever since by this development.

Implications of aetherial theory

The question remains as to what implications are to be drawn and what insights gained through the addition of an aether to physical theory? Historically, although all remember Einstein's role in disbanding the notion of an aether within accepted modern physics, few are as sharply aware of his position before his public refusal of an active aetherial medium. In an address delivered on May 5th, 1920, in the University of Leyden and also published again elsewhere^{11,12} the value Einstein once ascribed to the theoretical addition of an aether is clearly seen - **"Recapitulating, we may say that according to the general theory of relativity space is endowed with physical qualities; in this sense, therefore, there exists an ether. According to the general theory of relativity, space without ether is unthinkable; for in such space there not only would be no propagation of light, but also no possibility of existence for standards of space and time . . ."**

It appears that at one time Einstein himself saw the value of an aether within working physical theory as did Tesla. A different and more fruitful theoretical picture for understanding Tesla's views, which are now summarized, may be forthcoming in the light of the above mentioned work of Jack.

From **PIONEER RADIO ENGINEER GIVES VIEWS ON POWER**
by Nikola Tesla *New York Herald Tribune*, September 11, 1932

Tesla Says Wireless Waves Are Not Electromagnetic, But Sound In Nature, Holds Space Not Curved

"The so-called Hertz waves are still considered a reality proving that light is electrical in its nature, and also that the ether is capable of transmitting transverse vibrations of frequencies, however low. This view has become untenable since I showed that the universal medium is a gaseous body in which only longitudinal pulses can be propagated, involving alternating compressions and expansions

similar to those produced by sound waves in the air. Thus, a wireless transmitter does not emit Hertz waves which are a myth, but sound waves in the ether, behaving in every respect like those in the air, except that, owing to the great elastic force and extremely small density of the medium, their speed is that of light.”

and later

“I hold that space cannot be curved, for the simple reason that it can have no properties. It might as well be said that God has properties. He has not, but only attributes and these are of our own making. Of properties we can only speak when dealing with matter filling the space. To say that in the presence of large bodies space becomes curved, is equivalent to stating that something can act upon nothing. I, for one, refuse to subscribe to such a view.”

It appears that a longitudinal wave might be the source of electromagnetic transverse expressions.

What is the explanation for the divergence of speeds between the electric field propagating at light speed and the electron drift velocity which is very slow by comparison? Tesla appears to imply that the causal source of the transverse electrical effects seen is attributable to the T field: as a longitudinal scalar wave set of electrical pressure waves, voltage over time propagating through the aether at light speed constituting the electrical field itself, and then due to gyroscopic effects, the electrons once impacted by those longitudinal scalar waves precess¹³, creating observed transverse effects.

The field then, not the slow moving electron, appears as the causal source, and that field is created from longitudinal perturbations in the aether, a standing quantity, the scalar T field. It is interesting to note that Whittaker showed that the entire electromagnetic field may be derived from two scalar potential functions^{14,9}. As the T field expresses both positive and negative energy associated with negative and positive charge respectively, both positive and negative energies are seen all around, expressed in gravitation

⁹ see: Hadronic Journal, C. K. Whitney, Generalized functions in relativistic potential theory. vol 10, 1987, p. 289-290. and; T. Bearden, Gravitation, 1991, Cheniere press. p. 76.
⁴ such potentials are sometimes needed to replace classical EM with scalar interferometry in consideration of torqueing in multi-bodied systems.

and electromagnetism alike. Resorting to conceptualizations such a curved space time may then be avoided and instead, thought might be directed along the lines of aetherial densities.

Positive and negative energies are aetherial densities.

Questions that have long remained unanswered could finally become accessible such as those of clean energy production and gravitational theory. Long ago Maxwell saw the untapped energetic potential of aetherial densities in relation to gravitation. “. . . every part of this medium possesses, when undisturbed, an enormous intrinsic energy . . .” (ref 15, p. 39) Our previous work¹⁶ has made plain the relationships between gravity and the *T* field of Jack in the context of current engineering as exemplified in government designs that are admittedly based on the presence of an aether^{5,17,18}. It may be deduced that many of the basic definitions of physical processes become available. As time is reversed in *T* field negative energy expressions a graviton is seen to emerge as a series of transient photon - antiphoton pairs. A physical definition of the graviton as being the transient coupling of a photon and antiphoton of positive and negative energy respectively is, therefore, proposed. Dependent upon any particular systemic energy component balance and interactive expression, the rate and direction of time may vary. This then, constitutes our basic definition of the cause of the rate and passage of time: the transient coupling and dissociation of the system expressed gravitons. Similar, although not identical, ideas have been expressed elsewhere^{17,18}.

It appears that a great deal of negative energy is functioning alongside positive energy as the mediators of gravitational expressions *and time* within physical systems, just as the name Temporal Field implies.

Recalling that positive charge and the proton are associated with negative energy and gravitational expressions, note how a magnet, composed of charge balanced matter exhibits less strength of repulsion between like poles, than it does attraction between opposite poles. It may be hypothesized that the mass difference between charge balanced electrons and protons leaves a residual of attractive (negative) energy due to the proton's larger mass and hence energy which are greater than the electron's. So, as gravitons emerge along with mass across *T* field expressions, the negative energy residual leaves less energy between massive bodies, creating the

attraction of gravitation. The neutron is charge balanced with an electron bound within the proton⁵, but there is a neutrino needed, 0.782 MeV more positive energy and one-half spin are needed, the neutrino's positive energetic addition balancing energy, cancelling the negative energy gravitational residual in the neutron leaving a truly neutral particle energetically, once positive and negative energies are both taken into account.

In fact, the neutron itself may be best and most rightly understood through the model of Hadronic Mechanics¹⁹, an aether model which verifies its premises through experiments that make plain the inner construction and genesis of the neutron apart from the anomalies of accepted theoretical dogma. (ref. 5 and references therein) These theoretical alterations make available several proposed advances in physical theory stemming from the T field and its negative and positive scalar energies:

1. As negative T field energy is associated with positive charge, and positive T field energy with negative charge, the emergence of a graviton providing close atomic-range binding and orbital electron shell curvature across atomic structure between the electrons and corresponding protons is implied.
2. All binding energies in quantum chemistry are negative, implying negative energetic contributions bind molecular structures.
3. The electron hole within solid state physics is often characterized as a negative-mass valence band electron gone missing, implying that the top of the valence band functions as a negative energetic polarization yielding negative effective-masses²⁰.
4. As a possible causal source for observed transverse electrical wave effects and explanation for the divergence between electron drift velocities and field velocities.
5. As a heretofore unrecognized adherent, negative energetic contributor of positive charge accounting for like charge attraction, such as that demonstrated in clouds and bodily tissues.
6. Gravitational mechanics based in positive and negative energy theory.
7. Temporal mechanics based in positive and negative energy theory.

Within modern physics the idea of energy, although worked with in great precision and detail, has never actually itself been defined. To quote Feynman: "It is important to realize that in physics today, we have no

knowledge of what energy *is*." [Six easy pieces, R. Feynman, p.71]

Energy itself may now be defined as differences in positive and negative energetic densities within an aetherial medium that allow work to be carried out.

Please think of positive and negative temporal energies as aetherial densities that exist along a bivalent temporal scale with an atemporal equilibrium point between those opposing energetic expressions. As each energy type exerts its effects and is expended upon the system in the production of work, some additional portion of inefficiency and corresponding entropy is typically incurred leading in the case of both energy types to an overall systemic dynamism toward atemporal equilibrium. It is concluded that:

"Energy itself may now be defined as differences in positive and negative energetic densities within an aetherial medium allowing work to be carried out within a general propensity toward systemic equilibrium."

The causal thermodynamic basis?

Tesla states (Martin, 1995 p. 149)²¹:

"But of all the views on Nature, the one which assumes one matter and one force, and a perfect uniformity throughout, is the most scientific and the most likely to be true."

Jack states that the T field is invariably associated with a quantity of heat. We note in working government applications of the two T field energies that cooling is always associated with negative energy just as heating is always associated with positive energy^{5,17,18}. We note again that the T field appears in all systemic interactions, although it is only observable when time or motion is present. It is proposed that, just as one may infer from the work of Whittaker which demonstrates the electromagnetic field itself may be created entirely through the interference of scalar potential functions¹⁴, the T field is the causal field yielding the rest of physical and dynamic expression as an effect. It is proposed also that the T field itself is but heat within aether yielding the capacitance, the electrical potential needed to create the remainder of physical expression and observable temporal dynamics. Here is an electrical system based in thermodynamics. Note that vacuum is potentially a dielectric insulator²², and that vacuum is in fact aether. Due to

its uniform simplicity it is thought, as Tesla implied, that this is the model most likely to be true. Heat creates the magnetic field and electric fields within an aether. This proposition explains the anomalous thermomagnetic Seebeck effect where a magnetic field is created through heat²³. As is known, such a magnetic field can easily be the source of electrical field effects just to add motion to conductors. The thermo-motive force mentioned above contributes this motion and it may be seen that a single force emerges as causal, a thermoelectric motive force gained through capacitance fostered by heat within aether. This is a thermodynamic, and so, an electrical, motive, temporal system. The work of Jack and analysis of government work and weaponry seems to indicate that time itself is exactly that: *heat*.

It may be concluded that all universal effects inclusive of gravity⁵ are themselves electrical and magnetic effects, and, electrical and magnetic effects are a function of the interference between scalar potential functions as Whittaker has proved—and so, are all based in scalar T field heat. The background temperature of space within the aetherial medium sets the stage for time and the electrical and magnetic expressions that are physics and reality. Thermodynamics is the primary electrical and magnetic basis of time and physics.

Wave speed calculations:

One may use these mathematics outside of those traditional gauge theories attributable to Lorenz and Lorentz to calculate actual wave speeds of gravitational propagation. [5]

Jack's Analysis:

In his article, Jack takes as his starting point the assumption that the electromagnetic potential may be written

$$A = \phi + A_1 i + A_2 j + A_3 k,$$

where ϕ is the usual scalar potential and A_1, A_2, A_3 are the three components of the usual vector potential, denoted as usual by A and (d/dr) is the differential operator defined by

$$\frac{d}{dr} = \frac{1}{c} \frac{\partial}{\partial t} + \frac{\partial}{\partial x} + \frac{\partial}{\partial y} + \frac{\partial}{\partial z}.$$

Note that the non-bold A , as distinct from the bold A , denotes the quaternion which

Jack takes as his starting point.

Then, purely by inspection, the electric and magnetic fields as quaternions are seen to be given by

$$E = -\left\{\frac{d}{dr}, A\right\} = -(1/2)(d/dr \rightarrow A + A \rightarrow d/dr)$$

$$= -\frac{1}{c} \frac{\partial \phi}{\partial t} + \nabla \cdot A - \frac{1}{c} \frac{\partial A}{\partial t} - \nabla \phi$$

and

$$B = +[d/dr, A] = +(1/2)(d/dr \rightarrow A - A \rightarrow d/dr) = \nabla \times A.$$

Here there has been alternation between the more commonly used 3-vector notion and the 3-vector of Hamilton's quaternion notation, always taking care to match up the components of the appropriate expressions. It might be noted that the space components of these quaternion fields correspond exactly to the usual electric and magnetic fields encountered using the normal 3-vector calculus. However, the quaternion electric field has an extra – time component which is a scalar that may be denoted by T and given by

$$T = -\frac{1}{c} \frac{\partial \phi}{\partial t} + \nabla \cdot A \quad (1)$$

This leaves the usual expressions for the electric (E) and magnetic (B) fields in terms of the usual scalar and vector potentials:-

$$E = -\nabla \phi - \frac{1}{c} \frac{\partial A}{\partial t} \quad \text{and} \quad B = \nabla \times A \quad (2a,b)$$

Again purely by inspection, the reformulated Maxwell Electromagnetic Field equations are seen to follow from

$$[d/dr, B] = +\{d/dr, E\}$$

and

$$[d/dr, E] = -\{d/dr, B\}$$

This leads to slightly modified set of Maxwell Electromagnetic Field Equations:

$$\nabla \times B = \frac{1}{c} \frac{\partial E}{\partial t} + \nabla T \quad (3)$$

$$\nabla \times \mathbf{E} = -\frac{1}{c} \frac{\partial \mathbf{B}}{\partial t} \quad (4)$$

$$\nabla \cdot \mathbf{E} = +\frac{1}{c} \frac{\partial T}{\partial t} \quad (5)$$

$$\nabla \cdot \mathbf{B} = 0 \quad (6)$$

Then following the theoretical ideas as laid out in (for example) '*Classical Electricity & Magnetism*' by Abraham & Becker pages 220-221, it is seen that

Equation (6) implies $\mathbf{B} = \nabla \times \mathbf{A}$ and it then follows that (4) implies $\mathbf{E} = -\nabla\phi - \frac{1}{c} \frac{\partial \mathbf{A}}{\partial t}$.

When these values are inserted into (3) and (5), those equations become

$$\nabla \times \nabla \times \mathbf{A} + \frac{1}{c^2} \frac{\partial^2 \mathbf{A}}{\partial t^2} + \frac{1}{c} \nabla \dot{\phi} = \nabla T$$

and

$$-\frac{1}{c} \nabla \cdot \dot{\mathbf{A}} - \nabla^2 \phi = \frac{1}{c} \frac{\partial T}{\partial t}$$

The first of these equations simplifies to

$$\nabla(\nabla \cdot \mathbf{A}) - \nabla^2 \mathbf{A} = -\frac{1}{c^2} \frac{\partial^2 \mathbf{A}}{\partial t^2} - \frac{1}{c} \nabla \dot{\phi} + \nabla T$$

Then, to quote Abraham & Becker, (2b) only specifies the curl of the vector \mathbf{A} . Its sources are still at our disposal and these are *defined* by laying down the condition

$$\nabla \cdot \mathbf{A} = -\frac{1}{c} \dot{\phi} \quad (7)$$

Using this in the two preceding equations leads to

$$\nabla^2 \phi - \frac{1}{c^2} \frac{\partial^2 \phi}{\partial t^2} = -\frac{1}{c} \frac{\partial T}{\partial t}$$

and

$$\nabla^2 A - \frac{1}{c^2} \frac{\partial^2 A}{\partial t^2} = -\nabla T \quad (8)$$

respectively.

Results:

Note that from equation (1) above

$$T = -\frac{1}{c} \dot{\phi} + \nabla \cdot A$$

and, by (7), this gives

$$T = 2\nabla \cdot A = -\frac{2}{c} \dot{\phi}$$

so the new scalar field, T , which Jack referred to as the 'Temporal Field', is not zero when this identification is introduced but remains to make a definite contribution to the theory.

It follows that, if $B = 0$, then $A = \nabla S$ and (8) becomes

$$\nabla \left(\nabla^2 S - \frac{1}{c^2} \frac{\partial^2 S}{\partial t^2} \right) = -\nabla T$$

that is

$$\nabla \left(\nabla^2 S - \frac{1}{c^2} \frac{\partial^2 S}{\partial t^2} + T \right) = 0,$$

which, if $\nabla T = 0$, results in the equation for S given in that CIA released article mentioned in [5].

Note also that from the final equation above it may be deduced that

$$\nabla^2 S - \frac{1}{c^2} \frac{\partial^2 S}{\partial t^2} + T = 0,$$

if it is assumed that the constant of integration is zero. Again this assumption, because assumption it is, is in accordance with the above mentioned CIA article [5].

However, if T is given by equation (1) and since $A = \nabla S$, it follows that

$$T = 2\nabla^2 S$$

and substituting this into the equation above gives

$$\nabla^2 S - \frac{1}{c^2} \frac{\partial^2 S}{\partial t^2} + 2\nabla^2 S = 0$$

or

$$\nabla^2 S - \frac{1}{3c^2} \frac{\partial^2 S}{\partial t^2} = 0,$$

which indicates a wave speed of $c\sqrt{3}$; that is, a speed greater than that of light.

K. Thornhill [2] (1984) specifies the correct Total Time Derivative to be used in calculations specifying the medium's system dynamics as *bound to mass*, and so implying a return to a partial time derivative in the medium's unbound stationary state.

From K. Thornhill [2] (1984):

.. it is seen that, for general unsteady motion of a gas in three space- variables x_i , ($i = 1, 2, 3$) when the fluid velocity components are denoted by u_i , the governing equations may be written, using the summation convention,

$$\text{(Mass)} \quad \frac{Dv}{Dt} - \frac{v \partial u_i}{\partial x_i} = -Av^2$$

$$\text{(Momentum)} \quad \frac{Du_i}{Dt} + \frac{v \partial p}{\partial x_i} = B_i v$$

$$\text{(Energy)} \quad \frac{DS}{Dt} = v(H - Apv)/T$$

Here p denotes pressure, v specific volume, S specific entropy, T absolute temperature and the total time-derivative, moving with the fluid, is given by

$$\frac{D}{Dt} = \frac{\partial}{\partial t} + u_i \partial / \partial x_i \quad (9)$$

In the assembly of Maxwell's equations, the time-derivatives which occur in Ampère's rule and in the laws of induction have invariably been interpreted as the partial derivative $\partial/\partial t$. This is not acceptable in the concept of a gas-like ethereal medium, where the ethereal velocity may vary from point to point and with time, and the Newtonian frame of reference may be chosen so that its origin moves at any constant speed, independent of the ethereal motion. To satisfy the requirements of a gas-like ether unambiguously, the time-derivative in Ampère's rule and the laws of induction can only be interpreted as the total time-derivative moving with the ethereal flow, namely D/Dt , as defined in Eq. (9) above.

Once away from mass and the bound condition the return to the partial time derivative in the medium's stationary state then permits *near instantaneous* longitudinal wave propagation speeds. Wallace Thornhill states: "The crucial difference between the near-infinite speed of the electric force and the relative dawdle of light on any cosmic scale is that the electric force is longitudinal." [25]

PRACTICAL BENEFITS OF PARADIGM SHIFT

Should physics choose to adjust the paradigm to include an aether, the potential benefits to mankind and the sciences are extensive in their scope. [19]

An alternative method for disposal of high-level radioactive waste.

An alternative method for disposing of high-level radioactive waste has been proposed by Santilli. It is a form of neutralisation but does not use the conventional methods currently being researched. Indeed, classical formulations of quantum chemistry and nuclear models do not even permit the practical method proposed. This new method arises from a number of discrepancies between the theoretical and measured values using the current formulation of quantum mechanics. Conventionally, the probability for beta-decay of a neutron into a proton, electron and neutrino is very low for radioactive elements on a nuclear timescale; for stable isotopes, the lifetime of neutrons is effectively infinite. Hadronic mechanics predicts that such a reaction may be stimulated within the nuclei of radioactive materials.

In essence, a radioactive nucleus is in an excited energy state and is attempting to return to its ground state energy. Under normal circumstances, this is achieved by spontaneous fission or radioactive emission; the time taken to decay being dependent on how much excess energy the nucleus has. This can vary between 10^{-31} seconds and millions of years. An excited nucleus can return to its ground state through emission of a photon (gamma emission), an electron (beta emission), or by spontaneous fission, where alpha emission is assumed to be a form of fission. The latter two processes cause a change in the nature of the parent nucleus, altering its nuclear properties. The energy value of the excited state determines the method by which the nucleus returns to its ground state. If the decay process involves the emission of a beta particle, it may be extrapolated that a neutron will have to decay to achieve this.

From the theoretical calculations, it is hypothesised that this decay can be stimulated by bombarding the nucleus with so-called 'resonant' photons with an energy of 1.294 Mev [24]. Under normal circumstances the probability of this interaction is extremely low. However, Santilli claims that there is a large resonance peak in the reaction cross-section (that is, the probability of the said interaction occurring) for incident photons with an energy of 1.294 Mev.¹

If this interaction is found to be true, its application for the disposal of

1. It is also feasible, though not stated, that the simple existence of an excited nucleus makes it open to interaction with resonant photons, regardless of the means of decay ultimately used to return to its ground state energy. Once a neutron is converted into a proton plus reaction products, a number of possibilities could occur. Firstly, the new nucleus could be a stable isotope, in which case further interactions with the resonant photons would be unlikely and the waste would have been effectively neutralized. Secondly, the new isotope could form a new neutron deficient nucleus and one of the following could then occur: the nucleus undergoes spontaneous fission, forming two new nuclei and possibly a number of neutrons, which could interact with other fissile elements in the fuel and generate excess heat; the neutron deficient nucleus could form a new excited energy state which can simply be categorized as another target radioactive nucleus for the resonant photons.

radioactive waste is profound. Photons with the correct resonance energy can be produced easily within a piece of equipment of small volume, such that the neutraliser could be built on the same site as the parent reactor itself. Effectively, it would allow all radioactive waste to be fissioned until all the isotopes form stable nuclei. However, a point to note is that, taking a typical sample of waste, the resultant treated material would not be radioactively dangerous but chemically could be a totally unknown concoction of elements and compounds, which may well contain high levels of toxins. Another point to note is that stimulated fission would release a considerable amount of heat energy from the fuel, and so some sort of effective coolant would be required. However, since this heat energy could be used to produce even more power, there seems no reason in principle to suppose that what might be termed a secondary 'waste reactor' could not be built.

To continue quantitative scientific studies of the proposed new method for the disposal of nuclear waste essentially requires a few basic experiments to be performed. All should be of reasonable cost and are certainly realisable with present-day technology. It seems sensible to perform these experiments to decide whether or not the claims are valid. If they are, the rewards would be tremendous; if not, little would have been lost.

A. Hadronic fuels:

From the very beginning, one of the main driving forces behind Ruggero Santilli's hadronic science has been an urgent desire to help find new clean forms of energy for the benefit of all. To this end, hadronic mechanics has been developed and it is found that all energies predicted are suitable for the clean production of electricity and so may be used in the production of fuels acceptable in a so-called green economy. These new energies are found to be of three types; one at each of the particle, nuclear and molecular levels. These are all discussed in detail in the book on hadronic chemistry [24], although that volume does really concentrate on molecular aspects. However, the vitally important point to remember at all times is that the new proposed hadronic mechanics agrees with conventional theories everywhere except at short distances of the order of 10^{-13} cm. It is also important to remember that, at these short distances, many effects are non-potential ones and so may not be examined via the use of a Hamiltonian. These new effects are extremely short range and exhibit a number of unusual features:

- (i) the non-Hamiltonian interactions due to the deep mutual

overlapping of the particle wavepackets in singlet coupling are attractive and are so attractive as to overcome repulsive Coulomb interactions,

- (ii) they occur without any binding energy,
- (iii) these new interactions imply a mutation of the intrinsic characteristics of particles, characterised by irreducible representations of the Poincaré-Santilli isosymmetry, e.g. a deformation of the charge distribution of protons and neutrons is representable by hadronic mechanics and allows an exact representation of nuclear magnetic moments.

The attractive nature of these new interactions combined with their lack of energy exchange and the possible alteration of the intrinsic character of particles allow for truly new clean energies. It remains to consider briefly these three types of new energy as alluded to earlier;

- (1) Firstly consider that occurring at the elementary particle level.

It seems that the neutron harbours a huge reservoir of clean energy which could be.

made available to mankind. It is a naturally unstable particle with spontaneous decay

$$n \rightarrow p^+ + e^- + \bar{\nu},$$

which releases electrons with huge kinetic energies up to 0.8MeV. Here, and later, the traditional notation incorporating the symbols for anti-neutrino and neutrino are used.

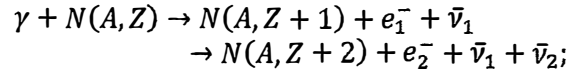
The capture of these electrons via a conducting screen provides a dual source of energy called hadronic energy. The first source is due to the creation of an electric potential difference, while the second is due to the creation of a large quantity of heat. This source is clean because no dangerous radiation is emitted and there is no harmful waste.

As is explained in detail in the book on Hadronic Chemistry [24], this so-called hadronic energy is based on three predictions:

- (a) A peripheral neutron belonging to a group of light, natural, stable elements $N(A, Z)$, called hadronic fuels, may be stimulated to decay via a flux of photons γ with a resonating frequency of 1.294MeV,

$$\gamma + n \rightarrow p^+ + e^- + \bar{\nu};$$

- (b) The resulting nuclei $N(A, Z+1)$ are naturally unstable with spontaneous beta decay



- (c) The final nuclei $N(A, Z+2)$ of the class of hadronic fuels are light, natural, stable elements and so, there is no deposit of harmful waste material.

Examples of these so-called hadronic fuels are $Z_n(70, 30)$ and $M_o(100, 42)$. It should be noted also that the energy of the original resonating photon is not lost but remains available in the final usable energy. Also, for each resonating photon there are two electrons and related kinetic energy produced. Again, in essence, the suggested process transforms the original nuclei into nuclei having smaller mass while producing large amounts of energy - large enough in fact to ensure a positive energy output after allowing for that needed to produce the original resonating photons. Obviously, hadronic energy is highly acceptable environmentally and it would seem that the suggested process readily delivers large amounts of usable energy. However, the entire theoretical discussion lies outside the realms of traditional theoretical physics, indicating a process which is impossible for traditional quantum mechanics. As will be noted again later, it does appear that this is what provides the most vociferous denunciation of this mentioned theory and the implied benefits for mankind if, in fact, the idea works. It does seem, though, to be a process worth evaluating independently both theoretically and experimentally since it could prove extremely beneficial for mankind if it works as expected.

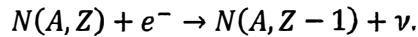
(2) New Clean Energies occurring at the Nuclear Level.

As mentioned already, one of the biggest obstacles facing these new proposals is the firmly established position of quantum mechanics within scientific circles. Orthodox quantum mechanics simply doesn't allow for some of these developments; for example, it doesn't even allow the possibility of low energy stimulated nuclear transmutations but, even if such processes are admitted, it is claimed such are accompanied by the emission of harmful neutrons. Experimental verification of stimulated nuclear

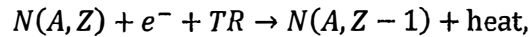
transmutations at low energy without the emission of neutrons would indicate direct support for this new theory which, in a very real sense, simply extends, or covers, existing quantum mechanical theory to include physical situations not addressed by that existing theory. However, in the present context, the crucial point is that the new theory predicts a totally new model for the structure of nuclei. In this new model, hadronic mechanics, they are reduced to being composed of electrons and protons but recovering the conventional structure in terms of protons and neutrons in first approximation. These new models are, as mentioned previously, a consequence of the neutron model as a hadronic bound state of a proton and an electron as originally conceived by Rutherford. It follows that the new clean energies of classes 1 and 2 are very deeply interconnected, to the extent that experimental evidence of one is experimental evidence of the other.

Three types of new clean energies emerge in this class but possibly the first is the most obvious:

- (a) This first source reignites thoughts about electron capture; that is, the spontaneous capture of electrons by certain nuclei under normal conditions on Earth. In truth, such electron capture implies the synthesis of neutrons from protons and electrons, leading to low energy transmutations of the form



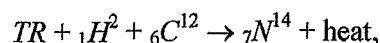
This reaction is spontaneous but hadronic mechanics has indicated how such transmutations may be stimulated with a release of energy:



- (b) A second group of energies of this second type may be identified by noting that the Earth's core is still so hot, after billions of years, that it must possess an internal source of heat which could well be due to nuclear transmutations such as envisaged above. It appears that observations, confirmed by hadronic mechanics, indicate that such nuclear transmutations may well be reproducible here on Earth.
- (c) A third group utilises the fact that, millions of years ago, the earth's atmosphere might have been composed of only 40% nitrogen. It is thought that the ensuing doubling of nitrogen content might well be due to nitrogen being synthesized in the atmosphere from other

natural elements via a low energy nuclear process without the emission of harmful radiation. This is a process permitted by hadronic mechanics but not by conventional quantum mechanics.

It seems quite possible that the trigger required to provoke this process is simply lightning. Also, the most plausible candidates as the natural elements to be in these processes are carbon and deuterium which occurs in small amounts in ordinary water. The stimulated synthesis of nitrogen predicted by hadronic mechanics would then follow



where the trigger in this case is lightning together with related events such as extreme magnetic fields. The low rate of such synthesis may be attributed to the low concentration of heavy water in our atmosphere. It should be noted that the energy output associated is impressive, [24].

As an interesting aside, it might be noted that the instantaneous availability of these large quantities of energy in this process provides an obvious explanation for thunder.

(3) New Clean Energies occurring at the Molecular Level.

In this class, the idea is to tap the energy within molecules; for example, via the transition from given molecules to structures at lower energy with practical use being made of the energy difference. These transitions would be utilised in hadronic reactors of molecular type, also called PlasmaArcFlow reactors, which are, incidentally, already in industrial production. More details of this category are readily available. [24]

It should be realised that the hadronic reactors of each of the three types considered are based on the same principle – that of stimulating the decay of considered bound states via resonating effects acting on the non-potential component of binding forces. This constitutes a totally different approach as compared with conventional approaches utilising traditional quantum mechanics. The main physical principles behind each of the three classes discussed are identical. Hence, the experimental verification of one class

gives immediate support for the existence of the other two classes. It is to be hoped that independent attempts at verification will be forthcoming soon because, if these classes do exist – and the present existence of operating PlasmaArcFlow reactors would appear to suggest that such attempted verification would be successful – the World's energy problems could be a thing of the past.

Further Thoughts.

All the above points strongly towards the reintroduction of the idea of an aether into the subject of physics. Thornhill certainly seems to have shown that the objections to such an existence as outlined so eloquently by Whittaker³ are not well founded. Also, Whittaker's own earlier work⁸ would also appear to support this assertion. On top of this, the recent work by Jack⁴ in causing the quaternion form of Maxwell's electromagnetic equations to resurface seems to add even more weight to the assertion. This, together with the revelations publicised recently⁵ concerning work covered in CIA documents recently made available again suggests a reworking of some long-held beliefs about the basis of much of physical theory.

If Thornhill is to be believed, an aether particle would weigh approximately 0.497×10^{-39} kg. It might be speculated that this would then be the basic constituent of all matter with the electron mass being roughly 2×10^9 times that of a unit aether particle. In one article¹, Thornhill proceeds to speculate on other important consequences, among which he notes that, if there is such a medium, the Universe must consist of an expanding flow of aether in which matter is suspended. In this case he notes that, if there are no aetherial shock waves, what are called 'world lines in unsteady fluid dynamics, but are really 'Universe lines' here, will be isentropic and, if further, the entire aetherial flow of the Universe is homentropic, one of the constants he introduces into his calculations, $c_0 h_0$, will be a universal constant. Here c_0 is the wave-speed obtaining in our galactic neighbourhood, at the present epoch, in the background radiation field and h_0 , or Planck's constant, is the present value in our galactic neighbourhood of a quantity which may vary with both time and position in the Universe.

All this indicates an urgent need to review much of the basis for modern physics as presently accepted and this is surely supported by the recent review⁹ of the present position concerning the real position of the view expressed in the famous paper by Einstein, Podolsky and Rosen¹⁰ as long ago as 1935.

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**GENERALIZED UNCERTAINTY RELATIONS, GENERALIZED
COMPTON WAVELENGTH AND PARTICLES IN A QUANTUM
FOAM DESCRIBED BY A VARIABLE ENERGY DENSITY**

David Fiscaletti

SpaceLife Institute – Via Roncaglia 35
S. Lorenzo in Campo (PU), Italy
spacelife.institute@gmail.com

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Abstract

A model of a dynamic three-dimensional quantum vacuum based on energy fluctuations of a granular space is considered as the keystone for the beyond Standard Model physics. By starting from a generalized version of uncertainty relations, a generalized Compton wavelength is defined which provides a unifying re-reading of elementary particles and black holes and an emergent interpretation of the Standard Model particles. Perspectives of this model as regards the treatment of Higgs boson and some relevant issues of the Standard Model are explored.

Key words: three-dimensional dynamic quantum vacuum, variable quantum vacuum energy density, generalized uncertainty relations, generalized Compton wavelength, beyond Standard Model physics.

1. Introduction

20th century theoretical physics introduced the concept of a unified quantum vacuum, which is not simply a purely geometrical container but is something endowed of an intrinsic energy density subtending the observable forms of matter, energy and space-time and ruling the processes on all space-time scales. However, despite the vacuum energy density appears in the cosmological constant as well as in quantum physics as zero-point energy, the physics of the previous century meets problems in order to provide a satisfactory interpretation of the so-called “empty space”, intended as a phenomenon which is associated with the non-existence in a region of fields, elementary particles and massive objects. In the Standard Model of particle physics it looks as if the quantum features of the vacuum, associated with its energy density and the difference between real and virtual particles, do not receive adequate attention.

The Standard Model – despite its extraordinary predictive power in the description of the elementary particles of matter and their interactions up to at least a few TeV and the recent discovery of the Higgs boson – is affected by several flaws that suggest the necessity to provide an extension of this theory, namely to develop what can be called a “beyond Standard Model physics” [1-4]. In this regard, in particular, one must face the problem to explain the smallness of the electroweak scale, the origin of tiny neutrino masses, the matter–antimatter asymmetry in the universe and, above all, the fact that the Standard Model can actually explain only the 5% of the things existing in the universe. In fact, in order to explain, on one hand, the accelerated expansion of the universe and, on the other hand, the existence of large scale dynamical phenomena, i.e. the formation of structures in the universe and their persistence today, the dynamics of galaxies and galaxy clusters, a mysterious form of diffuse dark energy probably pervading all corners of the universe and an elusive electrically neutral “dark matter” that is only subjected to gravitational interaction, are respectively invoked. Despite some different proposals of extensions of the Standard Model exist in the literature (and, in particular, the different perspectives of treatment of dark energy and dark matter [5-13]), all these fundamental topics require an adequate explanation yet.

In order to provide new perspectives of explanation, inside an unifying and emergent picture, of the existence of an intrinsic energy density describing an “empty space” intended as a primary physical reality as well as to develop a beyond Standard Model physics, I have recently developed a model of a three-dimensional (3D) dynamic quantum vacuum (DQV) which has the merit to build a bridge between quantum mechanics and general relativity [14-24]. In this model, the notion of a fundamental non-local quantum geometry and the notion of a space-time emerging from the deepest processes situated at the level of quantum gravity can be embedded and unified inside the same scheme. In the picture of a Planckian metric, this approach shows how and in what sense the fundamental background space of physical processes is a 3D DQV where each particle is determined by elementary

reduction-state (RS) processes of creation/annihilation of virtual particles-antiparticles pairs corresponding to opportune changes of an elementary energy density of space.

The fundamental insight of the 3D DQV model is that dark energy and dark matter do not exist as primary physical realities but constitute only manifestations of an underlying fundamental variable quantum vacuum energy density, which is the origin of the curvature of space-time too [14-24]. In other words, in this model, ordinary matter, dark matter and dark energy can be seen as emergent structures, forms of collective organizations, which come into existence as the upper manifestations of specific excited states of the DQV, which correspond to specific fluctuations of the quantum vacuum energy density.

On the basis of the model of the 3D DQV developed by the author of this paper, the absence of material objects in the outer intergalactic space, corresponds to the Planck energy density:

$$\rho_{pE} = \frac{m_p \cdot c^2}{l_p^3} \quad (1)$$

where m_p is Planck's mass, c is the light speed and l_p is Planck's length. The Planck energy density (1), which is the maximum value of the energy density of space and physically corresponds to the total average volumetric energy density, owed to all the frequency modes possible within the visible size of the universe, represents the origin of "empty" universal space in which there are no material objects and can be interpreted as a sort of "ground state" of the 3D quantum vacuum.

The appearance of ordinary matter can be associated to a specific diminishing of the quantum vacuum energy density corresponding to elementary reduction-state (RS) processes of creation/annihilation of virtual particle/antiparticle pairs. In other words, matter has origin from excited states of the 3D DQV characterized by a less energy density than the ground state. The excited state of the 3D DQV corresponding to the appearance of a material particle is defined (in the centre of that particle) by the energy density

$$\rho_{qvE} = \rho_{pE} - \frac{mc^2}{V} \quad (2)$$

and therefore by the change of the energy density

$$\Delta\rho_{qvE} \equiv \rho_{pE} - \rho_{qvE} = \frac{mc^2}{V} \quad (3),$$

with respect to the ground state, depending on the amount of mass m and the volume V of the particle.

Dark energy manifests itself as a collective emerging phenomenon of specific quantum vacuum energy density fluctuations on the basis of relation

$$\rho_{DE} \cong \frac{35Gc^2}{2\pi\hbar^4 V} \left(\frac{V}{c^2} \Delta\rho_{qvE}^{DE} \right)^6 \quad (4)$$

where \hbar is Planck's reduced constant, G is Newton's gravitational constant, V is the volume of the region under consideration, $\Delta\rho_{qvE}^{DE}$ are the specific fluctuations of the quantum vacuum energy density generating the action of the dark energy density. Finally, the action of dark matter, which is invoked to explain the rotation curves of galaxies, is associated with a more fundamental notion of polarization of the vacuum characterized by a fluctuating viscosity $\mu(t)$, which is generated by a "perturbative" fluctuation of the quantum vacuum energy density given by relation

$$\Delta\rho_{perturbative} = \frac{\mu\hbar c^2}{nVl_p^2\Delta\rho_{qvE_0}} \quad (5)$$

(where n is the number of the virtual particles in the volume into consideration and $\Delta\rho_{qvE_0}$ is the change of the quantum vacuum energy generating the appearance of matter at a rest mass). In this picture, the stabilized behaviour of the speed of the arms of spiral galaxies, with increasing distance from the core of the galaxy, as predicted by observations [17, 21, 24], is explained in terms of an exchange of the energy of the rotating galactic matter with the quantum vacuum fluctuations, which is determined by the perturbative fluctuation of the quantum vacuum energy density (5).

In this paper, our purpose is to explore the unifying scenarios which are introduced by the view of a variable energy density of a 3D DQV intended as a primary physical reality, towards a beyond Standard Model physics: we want to show how the ordinary Standard Model particles can be seen as the result of processes of collective organization regarding the activity of quantum vacuum energy density fluctuations at an ultimate scale, ultimately linked with the Planck scale, where particles and black holes are unified. The structure of the paper is the following. In section 2 we analyse the geometrodynamical properties of the microscopic structure of the 3D DQV by considering a modification of the Heisenberg uncertainty relations expressed by opportune generalized uncertainty relations and we explore how the current theoretical frameworks as well as experimental observations provide physical constraints on the size of the modifications of the geometry of space-time associated with this approach. In section 3 we will show in what sense the 3D DQV model leads to suggestive unifying perspectives of the microscopic regime of elementary particles and the macroscopic domain of black holes and we will analyse how, at a unifying scale of elementary particles and black holes – defined by an opportune generalized Compton wavelength – the action of the quantum vacuum energy density fluctuations leads to an emergent interpretation of Standard Model particles. In section 4, we introduce some new insights and keys of reading as regards the interpretation of Higgs boson as well as other important issues of the Standard Model. Finally, in section 5, we summarize the main results of the paper.

2. The generalized uncertainty relations in the three-dimensional dynamic quantum vacuum and its physical constraints

One of the main challenges in current theoretical physics lies in finding a satisfactory synthesis of quantum theory and general relativity into a unified structure. If various approaches have been developed towards such a theory in order to face quantum gravity, a major difficulty is represented by the lack of experimental evidence of quantum gravitational effects. On the other hand, the quantization of space-time itself can determine experimental effects, in the sense that the existence of a minimal measurable length physically leads to a modification of the Heisenberg uncertainty relation at an opportune scale near the Planck scale, which depends of a deformation parameter.

In the model of 3D DQV considered in this paper, the microscopic structure of the underlying background of processes is characterized by a deformation of the geometry expressed by the following generalized uncertainty relations, which are valid at the Planck scale:

$$\Delta x \Delta p \geq \frac{\hbar}{2} \left(1 + \beta l_p^2 \frac{\Delta \rho_{qvE}^2 V^2}{\hbar^2 c^2} \right) \quad (6) \quad [25].$$

In equation (6) β is a fluctuating parameter which expresses the fact that here space-time fluctuations fix the minimal length scale only on average, in analogy with what happens in quantum foam scenarios such as loop quantum gravity as well as cellular automaton interpretation of quantum mechanics [26-33]. The second term, $\frac{\hbar}{2} \beta l_p^2 \frac{\Delta \rho_{qvE}^2 V^2}{\hbar^2 c^2}$ appearing in relation (6) measures the degree of violations of the Heisenberg uncertainty relations at scales that approach the Planck scale.

The modifications of the Heisenberg uncertainty relations represented by equation (6) can be associated to the consideration of a quantization of space-time and thus to the existence of a minimum measurable length scale of the form

$$\Delta x_{min} = l_p \sqrt{\beta} \quad (7).$$

The relation between the existence of a minimal length and a modification of the Heisenberg position-momentum uncertainty principle at the Planck scale has been recently considered by several authors in many approaches to quantum gravity, such as string theory, doubly special relativity and in explorations of the properties of black holes [34-36].

As regards the different formulations of the generalized/modified uncertainty relations, in the previous decade an intense debate focused on the experimental predictions about the size of these modifications, namely about the bounds of the dimensionless parameter measuring the deviations from the standard Heisenberg relations. As a consequence of these results, the following scenario emerges as regards the constraints on the parameter β appearing in equation (6).

On one hand, a first estimate of constraints on the value of the parameter β comes by taking into account the absence of deviations from the standard Heisenberg principle at the electroweak scale, which leads to express the second term of right side of equation (7) as

$$\beta l_p^2 \frac{\Delta \rho_{qvE}^2 V^2}{\hbar^2 c^2} = \beta \frac{\rho_{qvE}^{EW}}{\rho_p} \ll 1 \quad (8)$$

thus implying $\beta \ll 10^{34}$. On the other hand, the study of Bushev et al. [37] provided an estimate of the upper bound of the parameter β of $\beta < 4 \cdot 10^4$ by considering the dynamical implications of the contorted commutator on the oscillations of a high-Q mechanical resonator with a sub-kilogram mass m of the resonating mode, thus probing deformed commutators with macroscopic harmonic oscillators. In Bushev's approach, one can consider a deformation in $\beta \hat{p}^4$ of the usual harmonic oscillator Hamiltonian and thus an Hamiltonian of the form:

$$H = \frac{\hat{p}^2}{2m} + \frac{1}{2}m\Omega_0^2\hat{x}^2 + \frac{\beta\hat{p}^4}{3m(M_{pl}c)^2} \quad (9)$$

where Ω_0 is the unperturbed value of the resonance frequency. The Hamiltonian (9) determines a amplitude dependence of the resonance frequency whose resolution is expressed by relation

$$\frac{\delta\Omega(A)}{\Omega_0} = (m_{eff}\Omega_0 A/M_{pl}c)\beta \quad (10)$$

where $\delta\Omega$ is the deviation of the amplitude-dependent resonance frequency $\Omega(A)$ from the unperturbed value Ω_0 , m_{eff} is the effective mass of the mode and A is the oscillation frequency. On the basis of equation (10), it is possible to set an upper limit for the model parameter β and, in this regard, in particular, Bushev's group performed an experiment with a quartz BAW resonator, estimating a limit of $\beta < 4 \cdot 10^4$. Moreover, in [38] an evaluation of the upper bound of $\beta < 10^{12}$ was found by measuring the timescale in which large molecular wave packets double its initial width.

A crucial topic connected to the modification of the Heisenberg uncertainty relations given by equation (6) lies in the fact that it corresponds to a deformation of the underlying canonical commutator, in the sense that these generalized uncertainty relations lead to the following modified commutator:

$$[x, p]_\beta = i\hbar \left(1 + \beta l_p^2 \frac{\Delta\rho_{qvE}^2 V^2}{\hbar^2 c^2} \right) \quad (11).$$

Up to date, no effect of a modified canonical commutator of the kind (11) has been observed in experiments. As regards the modified commutator (11) of the 3D DQV model, it must be emphasized that the Planck scale modifications correspond to $\beta \approx 1$ and are therefore untested. On the other hand, it must be emphasized that the modification of the commutator at quantum gravity regime is not unique in the sense that can also be expressed in other versions and experiments that can, in principle, discriminate between the various approaches [39].

Different theoretical frameworks provide bounds on β of gravitational origin, by considering a deformation of the Hawking temperature of a Schwarzschild black hole when computed through generalized uncertainty relations, thus yielding to the following result

$$\beta = -\frac{\pi^2 M^2}{4M_p^2} \varepsilon^2 \quad (12)$$

where ε is the deformation parameter associated with the horizon radius of the black hole of mass M . In this regard, if one invokes the measures of the precession of Mercury by considering the deformed metric

$$F(r) = 1 - \frac{2GM}{rc^2} + \varepsilon \frac{G^2 M^2}{r^2 c^4} \quad (13)$$

one obtains the following constrain on ε :

$$|\varepsilon| < 1,6 \cdot 10^{-4} \quad (14)$$

which implies the following bound on β :

$$|\beta| < 2 \cdot 10^{69} \quad (15)$$

Now, in the model of the 3D DQV explored in this paper, in affinity with the treatment of Scardigli et al. [40, 41], we want to show how one can obtain an exact value of the parameter β appearing in relation (6) by considering an opportune quantum deformation of a metric of the form (22) associated with the following Arnowitt-Deser-Misner mass

$$M_{ADM} = \frac{\Delta \rho_{qvE} V}{c^2} \left(1 + \frac{\hbar^2 c^2}{\beta l_p^2 \Delta \rho_{qvE}^2 V^2} \right) \quad (16)$$

which derives from the generalized uncertainty relations (6) if the one considers the substitution

$$\Delta p \rightarrow \Delta p + \frac{\hbar^2 c^2}{l_p^2 \Delta p} \quad (17).$$

The Arnowitt-Deser-Misner mass (16) leads to define a quantum-modified Schwarzschild metric of the form

$$ds^2 = F(r)c^2 dt^2 - F(r)^{-1} dr^2 - r^2 d\Omega^2 \quad (18)$$

where

$$F(r) = 1 - \frac{2G\Delta \rho_{qvE}^3 V^3}{M_{Pl}^2 c^8 r} + \varepsilon \frac{\hbar^2 \Delta \rho_{qvE} V}{l_p^2 M_{Pl}^2 c^6 r} \quad (19)$$

and $d\Omega^2 = d\theta^2 + \sin^2 \theta d\phi^2$ is the metric on the 3-sphere. The physical meaning of the metric (18) – equipped with equation (19) – lies in the fact that it determines the following expression for the horizon size

$$r_H = R'_S = \frac{2G\Delta \rho_{qvE}^3 V^3}{M_{Pl}^2 c^8} \left(1 + \varepsilon \frac{\hbar^2 c^2}{l_p^2 \Delta \rho_{qvE}^2 V^2} \right) \quad (20)$$

which, in the different regimes of the quantum vacuum energy density, becomes

$$r_H \approx \begin{cases} \frac{2G\Delta \rho_{qvE}^3 V^3}{M_{Pl}^2 c^8} & \text{if } \Delta \rho_{qvE} V \gg M_{Pl} c^2 \\ \frac{2GM_{Pl}}{c^2} \left(1 + \frac{\hbar^2 c^2}{\varepsilon l_p^2 M_{Pl}^2 c^2} \right) & \text{if } \Delta \rho_{qvE} V \approx M_{Pl} c^2 \\ \frac{2G\hbar^2}{\varepsilon l_p^2 c^6} & \text{if } \Delta \rho_{qvE} V \ll M_{Pl} c^2 \end{cases} \quad (21).$$

In the regime where the first expression of (21) holds, which coincides with the standard Schwarzschild radius, one finds the following expression for the deformed standard Hawking temperature:

$$T = \frac{\hbar c^5}{8\pi k_B G \Delta \rho_{qvE} V} \left\{ 1 + \varepsilon \left[\frac{\hbar^2 c^2}{l_p^2 G \Delta \rho_{qvE}^2 V^2} - \frac{M_{Pl}^4 c^{16}}{2G^3 \Delta \rho_{qvE}^6 V^6} \right] + \dots \right\} \quad (22).$$

On the other hand, by starting from the quantum-modified Schwarzschild metric (18) and by assuming the thermal character of the correction induced by the generalized uncertainty relations (6), one finds the following deformed Hawking temperature of a Schwarzschild black hole:

$$T = \frac{\hbar c^5}{8\pi k_B G \Delta \rho_{qvE} V} \left\{ 1 + \beta \frac{M_{Pl}^2 c^4}{4\pi^2 \Delta \rho_{qvE}^2 V^2} + \dots \right\} \quad (23) \quad [41].$$

Comparison between expressions (22) and (23) leads to relation

$$\beta \frac{M_{Pl}^2 c^4}{4\pi^2 \Delta \rho_{qvE}^2 V^2} = \varepsilon \left[\frac{\hbar^2 c^2}{l_p^2 G \Delta \rho_{qvE}^2 V^2} - \frac{M_{Pl}^4 c^{16}}{2G^3 \Delta \rho_{qvE}^6 V^6} \right] \quad (24).$$

Now, by taking into account that for any metric of the form (18) an effective Newtonian potential can be defined as

$$V(r) \cong \frac{c^2}{2} (F(r) - 1) \quad (25)$$

one obtains

$$F(r) = 1 + 2 \frac{V(r)}{c^2} = 1 - \frac{2G \Delta \rho_{qvE}^3 V^3}{M_{Pl}^2 c^8 r} - \frac{6G^2 \Delta \rho_{qvE}^6 V^6}{M_{Pl}^4 c^{16} r^2} \left(1 + \frac{mc^2}{\Delta \rho_{qvE} V} \right) - \frac{41}{5\pi} \frac{G^3 \Delta \rho_{qvE}^9 V^9}{M_{Pl}^6 c^{24} r^3} \left(\frac{l_p c^4}{G \Delta \rho_{qvE} V} \right)^2 \quad (26).$$

Finally, if one makes the identification

$$\varepsilon \left[\frac{\hbar^2 c^2}{l_p^2 G \Delta \rho_{qvE}^2 V^2} - \frac{M_{Pl}^4 c^{16}}{2G^3 \Delta \rho_{qvE}^6 V^6} \right] = - \frac{6G^2 \Delta \rho_{qvE}^6 V^6}{M_{Pl}^4 c^{16} r^2} \left(1 + \frac{mc^2}{\Delta \rho_{qvE} V} \right) - \frac{41}{5\pi} \frac{G^3 \Delta \rho_{qvE}^9 V^9}{M_{Pl}^6 c^{24} r^3} \left(\frac{l_p c^4}{G \Delta \rho_{qvE} V} \right)^2 \quad (27)$$

equation (23) yields the following result for the parameter β :

$$\beta \frac{M_{Pl}^2 c^4}{4\pi^2 \Delta \rho_{qvE}^2 V^2} = \frac{41}{40\pi} \left(\frac{l_p c^4}{G \Delta \rho_{qvE} V} \right)^2 \quad (28)$$

namely

$$\beta = \frac{82\pi}{5} \quad (29)$$

compatibly with the result obtained in [41].

An important consequence of the generalized uncertainty relation (6) lies in its influence on low energy experiments such as the Lamb shift and the Landau levels by virtue of the fact that any system with a well-defined quantum (or classical) Hamiltonian is perturbed near the Planck scale by a correction term of the form

$$H_1 = \frac{\beta \hbar^4 c^2}{\Delta \rho_{qvE} V} \quad (30).$$

Thus, in the case of a Hydrogen atom the effect of the generalized uncertainty relation (6) for the Lamb shift of the ground state is the following:

$$\frac{\Delta E_0(\text{Generalized uncertainty relations})}{\Delta E_0} \approx 10\beta \frac{\Delta \rho_{qvE} V E_0}{M_{Pl}^2 c^4} \approx 0,47 \cdot 10^{-48} \beta \quad (31)$$

where E_0 is the energy of the ground state. The result (31) implies that, if one assumes $\beta \approx 1$, then a non-zero, but virtually un-measurable effect of the generalized uncertainty relations (6) on quantum gravity, is predicted; instead, if this assumption

is not considered, the current accuracy of precision measurement of Lamb shift of about 1 part in 10^{12} sets the following upper bound

$$\beta < 10^{36} \quad (32).$$

Since the bound (32) is weaker than the one associated with the electroweak scale, the result (32) seems to indicate the existence of a new and intermediate scale between the electroweak and Planck scale [42].

In analogous way, one can show that the generalized uncertainty relation (6) modifies the Landau levels of a system in a constant magnetic field with a cyclotron frequency $\omega_c = \frac{eBc^2}{\Delta\rho_{qvE}V}$, on the basis of relation:

$$\frac{\Delta E_0(\text{Generalized uncertainty relations})}{\Delta E_0} \approx \beta \frac{\Delta\rho_{qvE}V\hbar\omega_c}{M_{Pl}^2c^4} \quad (33).$$

This means that, in the case of an electron in a magnetic field of 10 T, $\omega_c = 10^3 \text{GHz}$, one obtains:

$$\frac{\Delta E_0(\text{Generalized uncertainty relations})}{\Delta E_0} \approx 2,30 \cdot 10^{-54} \beta \quad (34).$$

The result (34) implies therefore that, if β is assumed of the order of 1, again the correction to the Landau levels is too small to be measured; instead, on the basis of the current measurement of accuracy of 1 part in 10^3 leads to the following constraint $\beta < 10^{50}$ (35)

which itself implies the existence of an intermediate scale between electroweak and Planck scale [42].

3. From the generalized Compton wavelength to an emergent interpretation of the Standard Model particles

The variable energy density of the 3D DQV can be associated to a deformation of the geometry of the background which has the fundamental property of leading to a suggestive unification of the microscopic regime of elementary particles and the macroscopic domain of black holes, in other words to the existence of a fundamental scale where Compton wavelength and Schwarzschild radius are unified.

The possibility that, at around the Planck scale, elementary particles and black holes receive a unifying description, has been recently explored by various authors [43-50]. In the theory developed by the author of this paper, by following the mathematical treatment considered in [43, 45, 48, 50], the crucial result lies in the fact that, by starting from the generalized uncertainty relations (6), one can define a generalized Compton wavelength in the linear regime, given by relation

$$R'_C = \frac{\hbar c}{\Delta\rho_{qvE}V} + \beta l_p^2 \frac{\Delta\rho_{qvE}V}{\hbar c} \quad (36)$$

and, above all, a more general, unified expression for the generalized Compton wavelength and Schwarzschild radius, which is also valid in the quadratic regime, given by relation

$$R'_C = R'_S = \sqrt{\left(\frac{\beta \hbar c}{\Delta \rho_{qvE} V}\right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvE} V}{\hbar c}\right)^2} \quad (37).$$

The physical meaning of equation (37) is that the fundamental quantum vacuum energy density fluctuations characterizing the underlying foam of virtual particles represented by the 3D DQV, imply the existence of a physical relation between the uncertainty principle on the scale of elementary particles and the regime of black holes in macrophysics. In other words, in the light of equation (37), one can say that the connecting loop between microphysics and macrophysics is represented by elementary objects of the Planck scale, namely sub-Planckian black holes with a size of order of their Compton wavelength, which are generated by the geometrodynamical properties of the variable quantum vacuum energy density ultimately associated to the foam of the virtual particles of the vacuum. The generalized Compton wavelength (37), which ultimately emerges from the generalized uncertainty relations (6), shows also that a unifying treatment of Casimir effect and cosmological wormholes is possible: the ultimate origin of the geometry of wormholes is represented by processes involving the 3D DQV and, here, the curvature and scale factor of the universe appear as upper manifestations of the elementary fluctuations of the quantum vacuum energy density as well as of the fluctuating parameter appearing in the generalized uncertainty relations [25].

Now, in this chapter, we want to show how the generalized Compton wavelength and Schwarzschild radius, given by equation (37), allows us to develop an interpretation of Standard Model particles as emerging events from the quantum vacuum energy density fluctuations, by following a process of collective organization. In this regard, by using the third quantization formalism developed in [51], in the geometry of the 3D DQV ruled by the generalized uncertainty relations (6), we suggest that the evolution of the wave function Ψ of each micro-universe (which is a function of the scale factor a of the universe and of the scalar fields φ associated with the quantum vacuum energy density fluctuations as well as the polarization of the vacuum) is ruled by a peculiar form of Wheeler-DeWitt (WDW) equation, intended as an equation of background, a real “equation of everything” where all the possibilities of the physical world are written in timeless form:

$$\ddot{\Psi} + \frac{k \left(\left(\frac{\beta \hbar c}{\Delta \rho_{qvE} V} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvE} V}{\hbar c} \right)^2 \right)^{3/2} \Delta \rho_{qvE}}{a c^2 \sqrt{a}} \dot{\Psi} + \omega^2(a) \Psi = 0 \quad (38).$$

In equation (38) the following important quantities appear: $\dot{\Psi} = \frac{\partial \Psi}{\partial a}$, α is the fine-structure constant, ω is the mode frequency linked with the scale factor, $\Delta \rho_{qvE}$ are the quantum vacuum energy density fluctuations corresponding to elementary RS processes of creation/annihilation of virtual particle/antiparticle pairs and, finally, k is an adimensional parameter corresponding to the size of the condensate of virtual sub-particles of the 3D DQV, namely represents a sort of effective parameter of density of

the virtual particles of the medium. Equation (38) may be defined as the “generalized WDW equation in 3D DQV”.

On the basis of equation (38), each micro-universe can be seen as a structure which derives from the activity of opportune quantum vacuum energy density fluctuations at the ultimate unifying scale represented by the generalized Compton wavelength and Schwarzschild radius (37). The wave function Ψ satisfying WDW equation (38) and therefore describing the behaviour of each micro-universe of the landscape of the 3D DQV, namely its corresponding particle, can be expressed as

$\hat{\Psi} =$

$$\frac{k \left(\left(\frac{\beta \hbar c}{\Delta \rho_{qvE} V} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvE} V}{\hbar c} \right)^2 \right)^{3/2} \Delta \rho_{qvE}}{\sqrt{2\pi} \hbar l_p^2} \int d\rho \left(e^{ik \frac{\left(\left(\frac{\beta \hbar c}{\Delta \rho_{qvE} V} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvE} V}{\hbar c} \right)^2 \right)^{3/2} \Delta \rho_{qvE}}{\hbar l_p^2} - \varphi} \Psi_{\Delta \rho_{qvE}}(a) \hat{b}_{\Delta \rho_{qvE}} + e^{-ik \frac{\left(\left(\frac{\beta \hbar c}{\Delta \rho_{qvE} V} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvE} V}{\hbar c} \right)^2 \right)^{3/2} \Delta \rho_{qvE}}{\hbar l_p^2} - \varphi} \Psi_{\Delta \rho_{qvE}}^*(a) \hat{b}_{\Delta \rho_{qvE}}^\dagger \right) \quad (39).$$

In equation (39), the operators $\hat{b}_{\Delta \rho_{qvE}}$ and $\hat{b}_{\Delta \rho_{qvE}}^\dagger$ are the annihilation and creation operators which annihilate and create respectively micro-universes, namely particles, associated with corresponding quantum vacuum energy density fluctuations, whose action occurs at the generalized Compton wavelength, and obey the so-called “quantum Boltzmann statistics”, or “Infinite statistics”, described by the following commutation relations between the oscillators

$$\hat{b}_k \hat{b}_l^\dagger - q \hat{b}_l^\dagger \hat{b}_k = \delta_{kl} \quad (40)$$

where q is a deformation parameter. In the light of equation (40), one obtains that the generation of bosons and fermions emerge in the peculiar cases $q = \pm 1$.

Moreover, here the production of a micro-universe (and thus the manifestation of a corresponding particle) corresponds to the generation of an information in a cell of the 3D DQV given by the following relation:

$$I = \frac{A}{l_p^2} \quad (41)$$

where

$$A = k \left[\left(\frac{\beta \hbar c}{\Delta \rho_{qvE} V} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvE} V}{\hbar c} \right)^2 \right] \quad (42)$$

is the area of the cell, which depends of the size of the condensate of the virtual sub-particles of the background. According to the approach based on equations (38)-(42), the following relevant consequences can be therefore derived. On one hand, one has

an informational scenario at the Planck scale able to give origin to compelling perspectives of unification between elementary particle physics and cosmology. On the other hand, one can choose opportunely the parameter k defining the size of the condensate of the virtual sub-particles of the medium in order to obtain the appearance of the desired particle of the Standard Model with its usual properties. In this regard, by using a fruitful result of the transactional approach [52-54], one can consider the possibility that the regime of ordinary Standard Model particles emerges as a phenomenon associated with the chronon scale $\frac{A^3}{l_p^2} \approx 10^{-13} cm$. Equation (41) implies that the generic micro-universe leads to the appearance of ordinary Standard Model particles if the information created in a cell satisfies relation $l^3 l_p \approx 10^{-13} cm$, namely, taking account of equation (42),

$$\frac{k^3}{l_p^2} \left[\left(\frac{\beta \hbar c}{\Delta \rho_{qvE} V} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvE} V}{\hbar c} \right)^2 \right]^3 \approx 10^{-13} cm \quad (43).$$

Equation (42) expresses in what sense the generalized Compton wavelength and the size of the condensate of the virtual sub-particles of the 3D DQV lead in a direct way to the minimum size of each spatial length characterizing the Planck lattice of the 3D DQV background, which gives rise to the appearance of the “bare” state of a particle, i.e. to the chronon scale. In other words, in the light of equation (43), the chronon scale of ordinary Standard Model particles can be interpreted as the emergence scale of processes of collective organization of opportune condensates of the virtual sub-particles of the 3D DQV which take place at the generalized Compton wavelength and are mathematically described by the wave function (39).

When the information associated with the fundamental cells of the multiverse satisfies relation $l^3 l_p \approx 10^{-13} cm$, namely equation (43), then the wave function of the micro-universe (39) undergoes a sort of quantum jump which leads to the appearance of the skeleton of a particle. The resulting event can be described through an internal wave function factor (inaccessible by direct observation) $\phi(\tau')$, null at the boundary and outside of the interval $\left[-\frac{l^3 l_p}{2c}, \frac{l^3 l_p}{2c} \right]$ where $l^3 l_p \approx 10^{-13} cm$, and whose evolution follows the law:

$$\begin{cases} -\hbar^2 \frac{\partial^2}{[\partial(2\pi\tau')]^2} \phi(\tau') = \left(\left(\frac{\beta \hbar c}{\Delta \rho_{qvE} V} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvE} V}{\hbar c} \right)^2 \right)^{3/2} \Delta \rho_{qvE} \phi(\tau') & \text{if } \tau' \in \left[-\frac{l^3 l_p}{2c}, \frac{l^3 l_p}{2c} \right] \\ \phi(\tau') = 0 & \text{otherwise} \end{cases} \quad (44).$$

On the basis of equation (44), it follows that the micro-universes described by the wave function (39) correspond to the usual real elementary particles when there is the following constraint regarding the quantum vacuum energy density fluctuations

$$\left(\left(\left(\frac{\beta \hbar c}{\Delta \rho_{qvE} V} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvE} V}{\hbar c} \right)^2 \right)^{3/2} \Delta \rho_{qvE} \right)^2 = n' \frac{\hbar c}{l_p^3} \quad (45)$$

where $n' = 0, 1/2, 1, 3/2, \dots$ is an integer for odd solutions, a half-integer for even solutions. In correspondence, the micro-universes can be associated to the appearance of a boson or a fermion as a consequence of the specific value of the deformation parameter q . Hence, it follows that the “bare” mass of the ordinary material particles of the Standard Model can be seen as the result of opportune diminutions of the quantum vacuum energy density corresponding to opportune elementary RS processes of creation/annihilation of virtual particles on the basis of relation

$$mc^2 = n' \frac{\hbar c}{l_p^3} \quad (46),$$

namely

$$mc^2 = n' \frac{\hbar c}{\frac{k^3}{l_p^5} \left[\left(\frac{\beta \hbar c}{\Delta \rho_{qvE} V} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvE} V}{\hbar c} \right)^2 \right]^{2/3}} \quad (47)$$

where

$$mc^2 = \left(\left(\left(\frac{\beta \hbar c}{\Delta \rho_{qvE} V} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvE} V}{\hbar c} \right)^2 \right)^{3/2} \Delta \rho_{qvE} \right)^2 \quad (48)$$

namely it is the fluctuations of the quantum vacuum energy density acting at the generalized Compton wavelength that give origin to the appearance of the property of the mass of ordinary particles of the Standard Model. Equations (47) and (48) physically provide the constraint that establishes what is the relation between the geometry of the 3D quantum vacuum characterized by virtual particle/antiparticle pairs and the quantum jumps regarding elementary particles of the Standard Model described by the chronon scale and ruled by the ordinary quantum laws. The physical meaning of equations (47)-(48) is therefore the following: the quantum vacuum energy density fluctuations associated with the virtual sub-particles of the 3D DQV, which act at the generalized Compton wavelength and whose evolution, at the ultimate level, is ruled by the generalized WDW equation (38), can be considered as the ultimate elements which give rise to the appearance of particles of the Standard Model at the Planck scale and, conversely, can be considered as the Planck signature of Standard Model particles.

4. Interpretation of Higgs boson and perspectives as regards some issues of the Standard Model

Within the Standard Model, the masses of all kinds of fermions are provided by the Higgs mechanism, whose mathematical formalism is expressed in terms of two parameters, namely the quadratic mass term and the dimensionless quartic coupling, which turn out to be strictly associated with the Higgs vev and the Higgs mass, once

spontaneous symmetry breaking is applied. If in the Standard Model, over the years, the Higgs mass was studied in terms of a mixture of themes, such as unitarity, perturbativity (corresponding to the fact that the Higgs mass was to be expected to be of order of the electroweak scale), vacuum stability and radiative corrections, instead our model of 3D DQV, whose ultimate geometry is described by the generalized Compton wavelength (36), suggests the crucial perspective that the Higgs mass can be derived as an emergent fact from the fundamental properties of the vacuum too.

In our approach, the Higgs Lagrangian responsible of the generation of the mass terms for the W and Z bosons of weak generations can be expressed in the form

$$\mathcal{L}_H = |D_\mu \Psi|^2 - V(\Psi) \quad (49)$$

where Ψ is an opportune solution of the generalized WDW equation (38), namely has the form (39) in operator form, and the Higgs potential $V(\Psi)$ is

$$V(\Psi) = \mu^2 \Psi^\dagger \Psi + \lambda (\Psi^\dagger \Psi)^2 \quad (50)$$

where λ is a positive parameter. For $\mu^2 < 0$ the gauge symmetry $SU(2)_L \times U(1)_Y$ of electroweak interactions is broken to $U(1)_{em}$ and, in this process, the pseudo Goldstone bosons can be associated to the emergence of the massive W and Z bosons. In this context, we know that, in the Standard Model, the non-physical degrees of freedom determined by the Higgs doublet are removed in the Unitary gauge, where the Higgs doublet can be written as

$$\phi = \frac{1}{\sqrt{2}} \begin{bmatrix} 0 \\ v+h \end{bmatrix} \quad (51)$$

where $v = \sqrt{\frac{-\mu^2}{\lambda}}$ and h is the excitation from the vev. As a consequence of (51), as is known, the Higgs potential of the Standard Model becomes

$$V(\psi) = \frac{1}{4} \lambda v^4 + \lambda v^2 h^2 + \lambda v h^3 + \frac{1}{4} \lambda h^4 \quad (52)$$

which yields the following relation as regards the Higgs mass: $m_H^2 = 2v^2 \lambda$.

Now, in our approach of the 3D DQV characterized by fundamental energy density fluctuations at the generalized Compton wavelength (37), in the Unitary gauge the Higgs doublet (51) becomes

$$\phi = \frac{1}{\sqrt{2}} \begin{bmatrix} 0 \\ \frac{1}{k \left(\left(\frac{\beta \hbar c}{\Delta \rho_{qvE} V} \right)^2 + \left(\frac{\beta \hbar c}{\Delta \rho_{qvE} V} \right)^2 \right)^{3/2} + h} \end{bmatrix} \quad (53)$$

where h indicates the excitations of the 3D DQV from the vacuum expectation value ε which is related to the rest mass of the W boson as

$$\varepsilon = \frac{\sqrt{2} c^2}{g} M_W \quad (54)$$

where g represents the electroweak coupling constant. Then, taking account of the results obtained in [55], by applying the Unitary gauge constraint, in our model, the Mexican hat potential which corresponds to the action of the Higgs field may be expressed as

$$V(\psi) = \frac{1}{4}\lambda \frac{1}{\left(\left(\frac{\beta\hbar c}{\Delta\rho_{qvEV}}\right)^2 + \left(\beta l_p^2 \frac{\Delta\rho_{qvEV}}{\hbar c}\right)^2\right)^6} + \lambda \frac{1}{\left(\left(\frac{\beta\hbar c}{\Delta\rho_{qvEV}}\right)^2 + \left(\beta l_p^2 \frac{\Delta\rho_{qvEV}}{\hbar c}\right)^2\right)^3} h^2 + \lambda \frac{1}{\left(\left(\frac{\beta\hbar c}{\Delta\rho_{qvEV}}\right)^2 + \left(\beta l_p^2 \frac{\Delta\rho_{qvEV}}{\hbar c}\right)^2\right)^{3/2}} h^3 + \frac{1}{4}\lambda h^4 \quad (55).$$

In other words, in our model, the parameter v invoked by the Standard Model is assimilated to the ultimate geometry associated with the generalized Compton wavelength. In equation (55) λ is a positive parameter which satisfies relation

$$\sqrt{\frac{\xi^2}{2\pi} k\omega m |\Psi|^2} = \frac{1}{\left(\left(\frac{\beta\hbar c}{\Delta\rho_{qvEV}}\right)^2 + \left(\beta l_p^2 \frac{\Delta\rho_{qvEV}}{\hbar c}\right)^2\right)^{3/2}} \quad (56),$$

where ξ is the scattering length between the virtual sub-particles of the 3D DQV, and m is the mass of these virtual sub-particles. Equation (56) leads to the following result as regards the parameter λ :

$$\lambda = \left[\frac{\xi^2}{2\pi} k\omega m |\Psi|^2\right]^{1/2} \left(\left(\frac{\beta\hbar c}{\Delta\rho_{qvEV}}\right)^2 + \left(\beta l_p^2 \frac{\Delta\rho_{qvEV}}{\hbar c}\right)^2\right)^{3/2} \quad (57).$$

Now, as regards the potential (55), it must be emphasized that the second term (that is quadratic in h) plays a crucial role, in the sense that it allows us to express the Higgs mass in terms of the properties of the 3D DQV at the generalized Compton wavelength as follows:

$$m_H^2 = \frac{2\left[\frac{\xi^2}{2\pi} k\omega m |\Psi|^2\right]^{1/2}}{k^2 \left(\left(\frac{\beta\hbar c}{\Delta\rho_{qvEV}}\right)^2 + \left(\beta l_p^2 \frac{\Delta\rho_{qvEV}}{\hbar c}\right)^2\right)^{3/2}} \quad (58).$$

Equation (58) establishes the condition which must be satisfied by the energy density fluctuations of the 3D DQV in order to generate the Higgs mass. On the basis of equation (58), the Higgs mass can be seen as an emergent fact from the activity of the quantum vacuum energy density fluctuations at the generalized Compton wavelength. We have thus demonstrated how, in our model of 3D DQV with a variable energy density, Higgs field is not a primary physical reality but can be interpreted as the upper emergent manifestation resulting from the interplay of opportune underlying quantum vacuum energy density fluctuations involved at the Planck scale.

As regards the interaction of the Higgs (58) with the gauge bosons, one can express it via the following equation

$$\left| \left(i \frac{g}{2} \sigma_i W_\mu^i + i \frac{g'}{2} B_\mu \right) \Psi \right|^2 = \frac{1}{k \left(\left(\frac{\beta \hbar c}{\Delta \rho_{qvEV}} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvEV}}{\hbar c} \right)^2 \right)^{3/2} + h} \times \left[g^2 (W_\mu^1)^2 + g^2 (W_\mu^2)^2 + (-g W_\mu^3 + g' B_\mu)^2 \right] \quad (59)$$

where g, g' are the gauge couplings. In the light of relation (59), one finds that the masses of the vector bosons are the following:

$$M_W = \frac{g}{2k_W \left(\left(\frac{\beta \hbar c}{\Delta \rho_{qvEV}} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvEV}}{\hbar c} \right)^2 \right)^{3/2}} \quad (60)$$

and

$$M_Z = \frac{\sqrt{g^2 + g'^2}}{2k_Z \left(\left(\frac{\beta \hbar c}{\Delta \rho_{qvEV}} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvEV}}{\hbar c} \right)^2 \right)^{3/2}} \quad (61),$$

where k_W is the constant associated to the condensate of virtual sub-particles of the vacuum corresponding to the appearance of a W boson and k_Z is the constant associated to the condensate of virtual sub-particles of the vacuum corresponding to the appearance of a Z boson. In this way, the weak mixing angle expressing the relationship between the masses of W and Z bosons in the Standard Model, in the approach of the 3D DQV becomes

$$\cos \theta_W = \frac{g k_Z}{k_W \sqrt{g^2 + g'^2}} \quad (62).$$

Finally, one can also find a new formulation for the Fermi constant

$$G_F = \frac{\sqrt{2}}{4} k_W^2 \left(\left(\frac{\beta \hbar c}{\Delta \rho_{qvEV}} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvEV}}{\hbar c} \right)^2 \right)^3 \quad (63)$$

and here, by taking account of the numerical experimental value of the Fermi constant, one directly obtains the following constraint regarding the electroweak scale:

$$\frac{1}{k \left(\left(\frac{\beta \hbar c}{\Delta \rho_{qvEV}} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvEV}}{\hbar c} \right)^2 \right)^{3/2}} \sim 246 \text{ GeV} \quad (64).$$

Moreover, the model of the 3D DQV developed in this paper suggests a natural explanation for the anomalous results known as “negative mass square problem”, in tuning with the results of [56] as regards a fundamental intrinsic relation between mass, gravity, space-time symmetry and the Higgs mechanism in a de Sitter (false) vacuum. In the light of the data on the solar and atmospheric neutrino [57], the neutrino oscillation is characterized by the following mass-squared difference for the neutrino oscillation, in two-flavour mixing approximation, which implies the existence of a strict link with the gravity-electroweak unification scale:

$$\Delta m_{atm}^2 = 2,5 \cdot 10^{-3} \text{ eV}^2; \quad \Delta m_{sol}^2 = 6,9 \cdot 10^{-5} \text{ eV}^2 \quad (65).$$

In our approach, in the interaction vertex a particle can be described by an eigenstate of the de Sitter Casimir invariants, given by relation

$$I'_1 = k^2 \left[\mu^2 c^2 \pm \frac{\hbar^2}{2r_0^2} \right] \quad (66)$$

where r_0 is the de Sitter radius, which is ultimately associated and derived from the more fundamental generalized Compton wavelength (37), namely:

$$r_0^2 = \left(\frac{\beta \hbar c}{\Delta \rho_{qvEV}} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvEV}}{\hbar c} \right)^2 \quad (67).$$

By taking account [58, 59], the state (66), assumes the form of a linear superposition of two different mass eigenstates related to the condensate of the virtual particles of the 3D DQV

$$m_1^2 = k^2 \left\{ \mu^2 + \frac{\hbar^2}{2c^2 \left[\left(\frac{\beta \hbar c}{\Delta \rho_{qvEV}} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvEV}}{\hbar c} \right)^2 \right]} \right\}, \quad m_2^2 = k^2 \left\{ \mu^2 - \frac{\hbar^2}{2c^2 \left[\left(\frac{\beta \hbar c}{\Delta \rho_{qvEV}} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvEV}}{\hbar c} \right)^2 \right]} \right\} \quad (68)$$

with equal weights. Moreover, by following [60], the mass-squared difference (65) can be associated directly with the unification scale M_{unif} of gravity and electroweak scale on the basis of relation

$$\Delta m^2 = \frac{8\pi}{3} k^2 \left(\frac{M_{unif}}{m_{Pl}} \right)^4 m_{Pl}^2 \quad (69).$$

Now, in our approach, the variable energy density of the 3D DQV, at the scale represented by the generalized Compton wavelength, in the gravito-electroweak vertex, has the fundamental effect of determining the emergence of an exact bi-maximal mixing for neutrinos, and therefore at this scale the condensate of the virtual particles of the medium is responsible of the generation of the mass-squared difference between atmospheric and solar neutrinos:

$$\Delta m^2 = \frac{\hbar^2 k^2}{2c^2 \left[\left(\frac{\beta \hbar c}{\Delta \rho_{qvEV}} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho_{qvEV}}{\hbar c} \right)^2 \right]} \quad (70)$$

for both the right and left handed fields. Equation (70) physically means that the mass-squared difference between atmospheric and solar neutrinos is an emergent effect from the condensate of the virtual sub-particles of the 3D DQV close to the Planck scale.

Now, by equating (69) and (70), one can obtain an expression for the gravito-electroweak scale M_{unif} in the 3D DQV ruled by generalized uncertainty relations as follows

$$\frac{8\pi}{3} k^2 \left(\frac{M_{unif}}{m_{Pl}} \right)^4 m_{Pl}^2 = \frac{\hbar^2 k^2}{2c^2 \left[\left(\frac{\beta \hbar c}{\Delta \rho q v E V} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho q v E V}{\hbar c} \right)^2 \right]} \quad (71).$$

Equation (71) yields the following expression of the unification scale

$$(M_{unif})^4 = \frac{3\hbar^2 m_{Pl}^2}{16\pi c^2 \left[\left(\frac{\beta \hbar c}{\Delta \rho q v E V} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho q v E V}{\hbar c} \right)^2 \right]} \quad (72)$$

namely

$$M_{unif} = \frac{1}{2} \left(\frac{3\hbar^2 m_{Pl}^2}{\pi c^2 \left[\left(\frac{\beta \hbar c}{\Delta \rho q v E V} \right)^2 + \left(\beta l_p^2 \frac{\Delta \rho q v E V}{\hbar c} \right)^2 \right]} \right)^{1/4} \quad (73).$$

On the basis of relation (73), in our model of 3D DQV, the gravito-electroweak scale M_{unif} turns out to be directly determined by the generalized Compton wavelength, but turns out to be independent of the parameter k indicating the size of the condensate of the virtual particles of the background. In this way, the mass-squared difference (70) of neutrinos determined by the activity of the vacuum at the Planck scale and associated with the virtual particles of the 3D DQV, lead to corresponding values of the unification scale for solar and atmospheric neutrinos respectively

$$M_{unif(atm)} \approx 14,5 \text{ TeV}; \quad M_{unif(sol)} \approx 5,9 \text{ TeV} \quad (74)$$

which turn out to be in good agreement with the results obtained in [55] as well as in other previous theories of electroweak unification [61-63]. The originality of this approach lies in the fact that the unification scale for solar and atmospheric neutrinos appears as an emergent phenomenon by starting from the activity of the virtual particles of the 3D DQV close to the unifying scale represented by the generalized Compton wavelength.

The approach developed in this paper introduces the insight to consider the generalized Compton wavelength as the fundamental scale at which the elementary processes taking place among the virtual particles of the 3D DQV lead to a unifying treatment of several issues related to the Standard Model. In this picture, maybe also the hierarchy problem (as well as maybe the gauge symmetries) could be resolved as a consequence of the specific behaviour of the quantum vacuum energy density fluctuations and, in particular, near to the scale M_{unif} associated with the virtual particles of the background generating the gravity-electroweak unification scale and which is given by equation (73).

On the other hand, a key theoretical issue in models of emergent Standard Model, is the scale of emergence. In this regard, by virtue of the link of the Higgs field as well as of the gravity-electroweak scale with the elementary properties of the vacuum, as formulated by equations (53) and (73), also the scale emergence can be seen as a collective result which derives from opportune condensates of elementary

energy density fluctuations of the 3D DQV associated with the activity of the virtual particles of the background.

Strictly related to the issue of the scales in the Standard model is the issue of the cosmological constant, that turns out to receive contributions from the physical vacuum. In our model of 3D DQV, these contributions can be formulated as follows:

$$\rho_{vac} = \rho_{qvE} + \rho_{potential} + \rho_{\Lambda} \quad (75)$$

where $\rho_{potential}$ is the potential energy density given by equation (51) and ρ_{Λ} is a renormalized version of the bare gravitational term [64, 65]. The vacuum energy density (75) turns out to be renormalization scale invariant, is directly responsible of the accelerating expansion of the Universe and is independent of the way it is calculated, namely

$$\frac{d}{d\mu^2} \rho_{vac} = 0 \quad (76).$$

In the light of its explicit μ^2 dependence and of the network of the virtual particles of the 3D DQV, the contributions to the quantum vacuum energy density ρ_{qvE} in equation (75) are scale dependent. In line with the results obtained in [2], in our model of 3D DQV whose geometry is ruled by the generalized Compton wavelength (37), one finds the following results: deep in the ultraviolet regime one has asymptotic freedom, while in the infrared confinement and dynamical chiral symmetry occur. The Higgs potential turns out to be renormalization scale dependent as a consequence of the scale dependence of the Higgs mass and Higgs self-coupling, which can be ultimately seen as the consequence of the processes of the virtual particles of the 3D DQV on the basis of equation (53) and determines the stability of the electroweak vacuum ultimately emerging from the unification scale (73).

Finally, we must remark that recently some issues seem to put at risk the theoretical implant of the Standard Model. In particular, scenarios towards a new physics could be opened by the so-called g-2 anomaly, regarding the discrepancy between theory and data of the magnetic dipole moment of the muon. Up to date the most part of physical explanations of the muon g-2 discrepancy invoke new scalar fields, for example axions. In [66] an alluring potential solution to the muon g-2 anomaly has been suggested in terms of heavy axion-like particle with couplings to leptons and photons, which provides a tantalizing potential solution to the muon g-2 anomaly. However, this recent approach which invokes axions does not manage to specify the origins of the axion couplings and other relevant degrees of freedom and this could be the clue of the existence of new fundamental particles existing in nature, that could be probed in future searches. In the light of the considerations made in this paper, the perspective is opened that these new fundamental particles, which take account the origin of axions, could be the virtual sub-particles of the 3D DQV, associated with the quantum vacuum energy density fluctuations at the generalized Compton wavelength. In this regard, further research will give you more information.

5. Conclusions

The model of a 3D DQV defined by a variable energy density intended as primary physical reality, by starting from a generalized uncertainty relation measuring the deformation of the geometry of the background near the Planck scale, leads to a suggestive unification of the microscopic regime of elementary particles and the macroscopic domain of black holes as emergent forms of collective organization which derive from more elementary objects of the DQV, in other words to the existence of a fundamental scale where Compton wavelength and Schwarzschild radius are unified. A generalized Compton wavelength describing the ultimate microscopic geometry of the 3D DQV emerges as the fundamental entity that introduces compelling scenarios of unification for the beyond Standard Model physics. Opportune condensates of quantum vacuum energy density fluctuations which take place at the fundamental scale represented by the generalized Compton wavelength can be seen as the fundamental structures which give rise to the appearance of particles of the Standard Model at the Planck scale and, conversely, can be seen as the Planck signature of Standard Model particles. Moreover, the elementary processes characterizing the activity of the 3D DQV at the generalized Compton wavelength imply that Higgs field manifests itself as a pattern of collective organization, lead to an emergent unification of the gravity-electroweak scale that is responsible of the mass-squared differences between solar and atmospheric neutrinos and introduce the possibility of a treatment of the hierarchy problem and of the gauge symmetries of the Standard Model in an emergent key, in terms of the collective features regarding the underlying activity of the virtual sub-particles of the vacuum characterizing this unification scale ultimately deriving from the generalized Compton wavelength. In the light of the considerations made in this paper, the model of the 3D DQV with a variable energy density, whose ultimate geometry is associated with the generalized Compton wavelength, can be considered a relevant attempt to provide a description of the so-called “quantum foam” in epistemological affinity with J.A. Wheeler’s program It from Bit (or Qbit) directed to describe the emergent features of space, time and matter as vehicled expressions of an informational matrix “at the bottom of the world” [67] and, at the same time, turns out to be compatible with an emergent view of physics. Although some improvements are obviously needed in order to clarify various aspects, the perspectives opened by the 3D DQV model can be considered a significant path directed to reach the unifying dreams of theoretical physics and in particular for the beyond Standard Model physics.

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VARIABILITY OF THE SPEED OF LIGHT

J. J. Bevelacqua

Bevelacqua Resources
7531 Flint Crossing Circle SE.
Owens Cross Roads, AL 35763
bevelresou@aol.com

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Abstract

General relativity suggests that the speed of light is influence by the gravitational potential. Several experiments illustrate variations in time attributed to the presence of the gravitational potential. These experiments can be interpreted to support the variability of the speed of light. However, this interpretation has not been definitively established or universally accepted.

Using the Schwarzschild metric, a quantification of the influence of gravity on the speed of light can be inferred. This paper proposes that the variation in the speed of light could occur most strongly in the vicinity of a massive object (e.g., in the vicinity of a massive black hole).

Keywords: General Relativity, Schwarzschild Geometry, Variability of the Speed of Light, Local and Global Reference Frames.

1.0 Introduction

Unlike the special theory of relativity, the general theory admits the possibility of the variability of the speed of light. Within the scope of general relativity, this variability is not definitively established or universally accepted.

Additional considerations involving the variability of the speed of light were provided by Santilli [(1) – (5)]. These include the importance of evaluating the local spacetime geometry and associated perturbations [1], incorporating inherent symmetries and conservation laws [2], variability of the speed of light with local physical conditions [3], arbitrary speeds for interior dynamical problems that are compatible with the abstract axioms of special relativity [4], and interior dynamics problems encountered in general relativity [5]. Santilli also established the variability of the speed of light within physical media utilizing new isomathematics [1]. Ahmar et al. [6] provide additional experimental confirmations of Santilli's assertions.

One of the key postulates of the special theory of relativity (SR) is that the speed of light c is a constant that is independent of the relative motion between inertial reference frames. A second postulate is the concept that the laws of physics are the same, and have the same form in all inertial reference frames. These postulates lead to a one to one correspondence between the metric tensor coordinates and the physical quantity (i.e., length and time)[7]. For example, the coordinate time t and proper time τ are the same.

This is illustrated by considering the coordinates utilized in special relativity in which spacetime is flat. Each inertial reference frame is distinguished from others by its relative uniform motion. There are no matter or energy perturbations in flat spacetime, but these occur in general relativity (e.g., mass distributions or sources of energy). These mass and energy sources alter the flat spacetime metric tensor that has the form:

$$g_{\mu\nu} = \text{diag}[+1, -1, -1, -1] \quad (1)$$

with an associated line element

$$ds^2 = g_{\mu\nu} dx^\mu dx^\nu \quad (2)$$

where x^μ are the metric coordinates. Matter and energy sources create curved spacetime and fall within the scope of general relativity. For specificity, the metric of (1) is utilized instead of $g_{\mu\nu} = \text{diag}[-1, +1, +1, +1]$ that is utilized in some texts including [8].

This situation is considerably more complex within the framework of general relativity that is illustrated by considering the field equations

$$G_{\mu\nu} = -\frac{8\pi G}{c^4} T_{\mu\nu} \quad (3)$$

where $G_{\mu\nu}$ is the Einstein tensor, G is the gravitational constant, and $T_{\mu\nu}$ is the energy momentum tensor [8]. The existence of mass and various source terms perturb flat spacetime and impact the postulates of special relativity. The effects of these source terms on the constancy of the speed of light (c) are the subject of this paper.

Variability of c is a controversial topic. Magueijo [9] outlines the various arguments supporting and challenges the variable c concept. [9] also describes the various theoretical arguments that lead to a variation in the speed of light within the scope of general relativity.

This paper reviews the various experiments supporting the gravitational time delay that support the variability of the speed of light, and offers additional theoretical arguments to support the variability. Using the Schwarzschild metric, the gravitational potential impact on the speed of light is quantified. It should be noted that although these assertions are speculative [9], the variability of the speed of light is an important concept that has astrophysical implications. These implications will also be reviewed.

2.0 Background

Variable speed of light has been investigated through a number of experiments that attempt to measure the gravitational effects on the concept of time. These basic concepts would affect the speed of light through the basic relationship: speed = length/time. Specific experiments that have investigated gravitational time dilation include the: (1) Hafele-Keating (HK) experiments [(10)-(12)], (2) Shapiro time delay test [(13) – (15)], (3) Gravity Probe A [16], (4) Global Positioning System [17], (5)

gravitational frequency shift (gravitational redshift) [(18) , (19)], and (6) Pound-Rebka experiment [(20), (21)]. Each of these experiments is summarized in subsequent sections. There are other experiments that also suggest temporal effects, but the aforementioned set of experiments is representative.

The aforementioned tests will be reviewed in terms of their impacts on time as affected by the strength of the gravitational field. In particular, the variability of the speed of light depends on the gravitational influence on time as noted in the aforementioned experiments. In a simplistic manner, variable speed of light c' depends on the gravitationally altered length l' and time (t') changes resulting from the influence of the gravitational potential

$$c' = \frac{l'}{t'} \quad (4)$$

The aforementioned experiments address time induced changes resulting from the gravitational potential. Length contraction within the scope of general relativity is also suggested [(22) – (24)].

This assertion of (4) is based on the assumption that the definition of speed in general relativity is essentially the same as the definitions utilized in classical mechanics and special relativity. The speed of light should have no global significance in general relativity because it depends on the length and time intervals that are well defined locally, but not globally. The lack of global definitions for length and time arise from the variability of generalized, curved Riemannian spacetime. Therefore, it may be argued that the speed of light is constant locally, but not globally with the variability induced by the gravitational potential.

These arguments are also supported by general considerations of inertial reference frames in curved spacetime. In general, there are no global inertial frames in the curved spacetime within the scope of general relativity that extend over the full spacetime domain. However, there are local inertial frames in the neighborhood of each point and in the vicinity of freely falling observers. However, there are no such global inertial reference frames. Therefore, there is an argument to be made for a distinction between local and global physical quantities including the speed of light.

Although variability of the speed of light is not a universally accepted concept, a theoretical argument is presented in this paper. This argument is based on consideration of the Schwarzschild metric, but the results can be generalized to other Riemannian geometries.

2.1 Hafele-Keating (HK) Experiment

The HK experiment was conducted in 1971 [(10) – (12)]. It is based on the combined time dilation effects caused by motion (special relativity) and the gravitational potential (general relativity). The experiment utilized atomic clocks and compared airborne and ground times.

Four cesium atomic clocks were flown on flights around the world. This was performed in eastward and westward directions to test Einstein's theory of relativity. Using flight data for each trip (e.g., altitude and velocity), the theory predicts that the airborne clocks, compared to reference clocks at the U.S. Naval Observatory should have lost 40 ± 23 nanoseconds during the eastward trip, and gained 275 ± 21 nanoseconds during the westward trip [10]. Relative to the atomic time scale of the U.S. Naval Observatory, the flying clocks lost 59 ± 10 nanoseconds during the eastward trip and gained 273 ± 7 nanoseconds during the westward trip, where the errors are the corresponding standard deviations [11].

As expected the airborne clocks exhibited time dilation caused by the motion of the east and west reference frames relative to the earth, and the differences in gravitational potential between the aircraft and ground elevations. The effects are small, but detectable. Larger gravitational fields would be expected to significantly increase the time dilation effect.

2.2 Shapiro Time Delay Test

The Shapiro time delay test [(13) – (15)] is an explicit experiment designed to provide additional confirmation of Einstein's theory of general relativity. This test measured the time delays between transmission of radar pulses directed toward Venus and Mercury. Subsequently, the detection of the reflections from these signals were determined. In accordance with the theory of general relativity, the speed of light depends

on the strength of the gravitational potential characterized by the trajectory. Shapiro notes that, these time delays should be increased by almost 2×10^{-4} s when the radar signals pass near a strong gravitational source (i.e., the sun). The dependence of the speed of light on the gravitational potential supports the proposed work.

Shapiro et al. [15] noted that these echoes are expected on the basis of general relativity to be retarded by solar gravity by an amount

$$\Delta t \approx \left(\frac{4r_o}{c} \right) \ln \left[\frac{(r_e + r_p + R)}{(r_e + r_p - R)} \right] \quad (5)$$

where Δt , expressed in harmonic coordinates, is the coordinate-time retardation, $r_o = 1.5$ km is the gravitational radius of the sun, c is the speed of light far from the sun, r_e is the earth-sun distance, r_p is the planet-sun distance, and R is the Earth-planet distance. The quantity Δt [15] is indicative of the magnitude and behavior of the measurable effect as predicted by general relativity. To determine if the time delay data are in agreement with this theory, Shapiro et al. [15] inserted an *ad hoc* multiplicative parameter λ on the right side of (5). A value of $\lambda = 1.0$ would indicate agreement with the predictions of general relativity. The HK experiment was first performed by Shapiro et al. in 1967 [14], and yielded the result $\lambda = 0.09 \pm 0.2$. Shapiro et al. [15] performed additional measurements with a resulting value of $\lambda = 1.01 \pm 0.02$, and this result resolved the inconsistencies in the previous preliminary analysis [14]. This experiment reinforces the validity of the time delay predicted by general relativity, and the associated variability of the speed of light.

2.3 Gravity Probe A

Gravity Probe A was a joint collaboration of the Smithsonian Astrophysical Observatory and the George C. Marshall Space Flight Center [16]. The experiment tested gravitational induced time dilation involving a frequency comparison of continuous wave microwave signals generated from hydrogen masers. These devices were located in a spacecraft at an altitude of about 10^4 km and on the surface of the earth. Agreement of the observed relativistic frequency shift with the predictions of general relativity is at the 70×10^{-6} level.

2.4 Global Positioning System

Ashby [17] provides a description of the Global Positioning System (GPS) and the importance of applying the concepts of general relativity to ensure that it effectively functions. The GPS uses accurate, stable atomic clocks located on satellites and on the earth's surface to provide a precise global position and time determination. These clocks exhibit both gravitational and motional frequency shifts.

The gravitational effects are defined by general relativity and the motional consequences by special relativity. These effects are sufficiently large, and must be included in the GPS design or the system would not properly function. In particular the GPS must consider a number of relativistic effects [17] including the: (1) constancy of the speed of light, (2) equivalence principle, (3) gravitational frequency shifts, (4) relativity of synchronization, (5) Sagnac effect, and (6) time dilation. In the context of the GPS, the constancy of the speed of light is applicable locally (i.e., in the vicinity of earth's weak gravitational field where spacetime is effectively flat [8]).

2.5 Gravitational Frequency Shift (Redshift)

The gravitational redshift was predicted by Einstein's general theory of relativity [18]. Consider two clocks located in differing gravitational potentials. According to the equivalence principle, the stationary clock exhibits a frequency shift [19]

$$\frac{\Delta\nu}{\nu} = \frac{\Delta U}{c^2} \quad (6)$$

where $\Delta\nu/\nu$ is the fractional frequency difference and ΔU is the gravitational potential difference between the two clocks locations. A successful measurement requires precision time measurements at the accuracy level of obtained by an atomic clock [19].

To achieve this level of precision, Shen et al. [19] proposed a gravitational redshift test based on frequency signals transmitted between a spacecraft and a ground station. The approach integrates one uplink signal from ground to spacecraft and two downlink signals from spacecraft to ground. The frequency shift is obtained by correlating the three frequency values.

As proposed by Shen *et al.*, using signal integration and correction models, the gravitational shift of the signals between spacecraft and ground station can be detected at a sufficiently high level of high precision. The gravitational redshift from these proposed frequency measurements provide an additional test that validates the time dilation effect.

2.6 Pound-Rebka Experiment

The Pound-Rebka experiment was designed to measure the gravitational frequency shift [(20), (21)]. This experiment measured the redshift of light traversing a gravitational field. Equivalently, the experiment is a test of the prediction of general relativity that suggests that clocks should run at different rates at different locations in a gravitational field.

Pound and Rebka outlined an experimental approach [20] to measure the gravitational redshift utilizing a ^{57}Fe photon source over a vertical distance of about 25.5 m [21]. The experiment [21] was performed to measure the effect of the gravitational potential differences at the surface of the earth and at an elevation of about 22.5m.

[21] determined a net fractional shift of $-(5.13 \pm 0.51) \times 10^{-15}$. The observed shift agrees with the predicted gravitational shift of -4.92×10^{-15} for the two-way height difference utilized in the experiment.

3.0 Field Equations of General Relativity

The Einstein tensor $G_{\mu\nu}$ represents the geometric component of spacetime and the energy-momentum tensor $T_{\mu\nu}$ quantifies its physical matter and energy properties [8] as given in (3). In (3), $T_{\mu\nu}$ provides a source term for general relativity which is no longer restricted to the simplifying assumptions of special relativity. In particular, spacetime is no longer restricted to be flat and curvature is permitted. In curved spacetime, the metric tensor coordinates do not necessarily represent the physical coordinates. These considerations are addressed in subsequent discussion.

4.0 Schwarzschild Geometry

Differences between metric coordinates and physical coordinates are illustrated by considering the Schwarzschild geometry. The

Schwarzschild spacetime geometry in spherical coordinates (t, r, θ, ϕ) [8] is

$$g_{\mu\nu} = \text{diag} \left[1 - \frac{2GM}{c^2 r}, - \left(1 - \frac{2GM}{c^2 r} \right)^{-1}, -r^2, -r^2 \sin^2(\theta) \right] \quad (7)$$

The Schwarzschild metric is selected because there is no temporal variable, and it is time independent and spherically symmetric. This metric describes the geometry of spacetime, exterior to a static, spherically symmetric, nonrotating, and electrically uncharged body of mass M surrounded by empty space. The mass M does not vary in space or time by either translation or rotation. There is no change in its mass distribution or internal density distribution. The mass distribution has spherical symmetry, and is a function of the radial coordinate r with no dependency on θ or ϕ .

The condition of empty space implies the metric is the vacuum solution with $T_{\mu\nu} = 0$. Therefore, the field equation (3) reduces to

$$G_{\mu\nu} = 0 \quad (8)$$

5.0 Relationship between Coordinate Time and Proper Time

The Schwarzschild metric is utilized to review the properties of time within the context of general relativity. To illustrate the temporal characteristics, consider a stationary frame in the Schwarzschild spacetime, and events that only vary in time (i.e., $dr = d\theta = d\phi = 0$). Accordingly,

$$ds^2 = d\tau^2 = \left(1 - \frac{2GM}{c^2 r} \right) dt^2 \quad (9)$$

where t is the coordinate time and τ is the proper time. The proper time interval $d\tau$ is shorter than the coordinate time interval dt by a factor of

$\left(1 - \frac{2GM}{c^2 r} \right)^{1/2}$. Coordinate time and proper time intervals are only equal

when $r \rightarrow \infty$. If there are two stationary reference frames K^1 at r_1 and K^2 at r_2 with $r_1 < r_2$

$$d\tau_1 = \left(1 - \frac{2GM}{c^2 r_1}\right)^{1/2} dt \quad (10)$$

$$d\tau_2 = \left(1 - \frac{2GM}{c^2 r_2}\right)^{1/2} dt \quad (11)$$

(10) and (11) suggest that $d\tau_1 < d\tau_2$ because $r_1 < r_2$. The result is significant because the proper time varies with distance from the mass M . This effect does not occur in special relativity. In particular, (10) and (11) suggest time runs slower closer to the source of gravity (i.e., the mass M) where the gravitational field is larger. The reader should note that the coordinate time t is not subscripted because the coordinate time is common to all frames of reference since it is a global coordinate. However, τ varies locally and is not a global coordinate.

6.0 Relationship between Spatial Coordinates and Proper Time

In a discussion similar to that of Section 5.0, consider a stationary frame at a specified distance from the mass M in the Schwarzschild spacetime, and consider events with no time variation ($dt = 0$). With this limitation,

$$ds^2 = \left(1 - \frac{2GM}{c^2 r}\right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2 \theta d\phi^2 \quad (12)$$

The discussion is simplified by considering the angular and radial components separately. For the angular component, $dr = 0$ and

$$ds^2 = r^2 d\theta^2 + r^2 \sin^2 \theta d\phi^2 \quad (13)$$

which is the same quadratic form in 3 dimensional spherical coordinates on a sphere of constant r . This suggests that gravity has no direct effect on

the circumferential component of length. Therefore, the constant r surfaces are similar to their flat space spherical coordinates. The results are more complex for the radial component (i.e., $d\theta = d\phi = 0$)

$$ds = \left(1 - \frac{2GM}{c^2 r}\right)^{-1/2} dr \quad (14)$$

If two stationary frames K^1 at r_1 and K^2 at r_2 with $r_1 < r_2$ are considered, and the discussion is limited to the radial component only

$$ds_1 = \left(1 - \frac{2GM}{c^2 r_1}\right)^{-1/2} dr \quad (15)$$

$$ds_2 = \left(1 - \frac{2GM}{c^2 r_2}\right)^{-1/2} dr \quad (16)$$

(15) and (16) suggest $ds_1 > ds_2$ because $r_1 < r_2$.

In a manner similar to the discussion of Section 5.0, dr is not subscripted because the radial coordinate is common to all reference frames since it is a global parameter. The proper length varies with the distance with $ds_1 > ds_2$ for $r_1 < r_2$. From a theoretical perspective, length is contracted further from the source of gravity where the field is weaker.

In special relativity, length is contracted with respect to two global, inertial reference frames in relative motion with respect to each other. In particular, length contraction in special relativity is dependent upon the velocity difference between the reference frames. In general relativity length contraction is caused by gravity and is a function of the spacetime location (i.e., the local metric characteristics of spacetime).

7.0 Local and Global Reference Frames

The previous sections address general considerations for the behavior of length and time in local and global reference frames. Within the context of special relativity, the constant speed of light is an inherent

postulate. This speed is constant both locally as well as globally. Inertial reference frames ensure that the speed of light is constant locally as well as globally in flat spacetime.

The question of reference frames is also an important consideration in general relativity. In general relativity, there are no global inertial reference frames in curved spacetime. However, there are local inertial frames surrounding each spacetime location. These local inertial reference frames also exist near world lines of freely falling observers. However, similar global frames do not exist in general relativity. This suggests that the postulates of special relativity will be observed locally in general relativity, but not globally. As a result, the speed of light will be constant locally in general relativity, but not globally. This assertion is addressed in more detail in subsequent discussion.

8.0 Implications for the Constancy of the Speed of Light

The basic definition of velocity (i.e., dx^i/dt in a coordinate representation or $ds/d\tau$ in a physical definition) is readily defined within the context of classical physics and special relativity. However, this interpretation is less obvious within general relativity in a strong gravitational field.

In special relativity, velocity and the speed of light are global quantities that are supported by Einstein's postulates. However, in general relativity length and time have no global significance. Length and time are constant locally, but not globally. Specifically, the speed of light is readily defined in special relativity since it is a global quantity. In general relativity, the definition is more complex

$$c' = \frac{ds_i}{d\tau_i} \quad (17)$$

where c' is the local speed of light that is constant locally, but not globally. (17) is justified by the distinction between local and global velocity, and is consistent with (4) as well as the previous discussion regarding physical quantities in local and global reference frames.

Using (10), (15), and (17), the local speed of light can be quantified in terms of the Schwarzschild metric

$$c' = \frac{\left(1 - \frac{2GM}{c^2 r_i}\right)^{-1/2} dr}{\left(1 - \frac{2GM}{c^2 r_i}\right)^{1/2} dt} = \frac{1}{\left(1 - \frac{2GM}{c^2 r_i}\right)} c \quad (18)$$

where $c = dr/dt$ is the global speed of light as defined in the special theory of relativity. (18) suggests that the variation in the speed of light depends on the factor $(1 - 2GM/c^2 r_i)^{-1}$. A test of the validity of the local nature of the speed of light in general relativity would depend on this factor. This could be most clearly observed for large values of M and/or small values of r_i . For example, measurements close to a massive black hole could reveal the postulated variation in c , but these measurements are beyond current scientific capabilities.

These and similar measurements would provide a definitive resolution to the possibility of the local variability of c within the scope of general relativity. Until such measurements are forthcoming, the proposed variation must be considered as speculative.

The conditions of (18) could also be met during a big bang/big crunch cycle. Variation in c would explore the initial time post big bang/big crunch including the concept of cosmic inflation. The variability of c would be integral to various theories involving this initial time period.

Inflationary cosmology within the context of general relativity is addressed in (22) and (23). In particular, inflationary cosmology is believed to explain the isotropy, large scale homogeneity, and flatness of spacetime. Additionally, general relativity predicts the deviations from homogeneity of our universe.

[25] suggests that these arguments are not the only option to explain these features of the universe. Moffat proposed a model in which local Lorentz invariance is spontaneously broken in the very early universe, and in this epoch the speed of light undergoes a first or second order phase transition to a value approximately 30 orders of magnitude smaller, corresponding to the presently measured speed of light. [25] also argues that there are additional attractive features of a variable speed of light theory compared to standard inflationary theory, and that it provides an alternative cosmology with potentially different predictions.

Moffat [26] also argues that a representative cosmology is obtained in which the causal mechanism of generating primordial perturbations is achieved by varying the speed of light in a primordial epoch. This yields an alternative to inflation for explaining the formation of the cosmic microwave background and the large scale structure of the universe. Moffat's arguments provide additional motivation for studies of the variability of the speed of light.

9.0 Conclusions

The variability of the speed of light is an open theoretical issue that requires experimental verification. Gravitational time delay has been observed, but relating this observation to the variability in the speed of light depends upon defining velocity in terms of local and global reference frames. Within the context of the Schwarzschild metric, the variability of the speed of light is inferred from a consideration of local reference frames. The degree of variability depends on the strength of the gravitational potential generated by a massive object. Variable speed of light has cosmological implications including the viability of cosmic inflation as well as the evolution of the universe from the initial initiating event.

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THE ORIGIN OF THE FUNDAMENTAL CONSTANTS

José Garrigues Baixauli
E.T.S.I. Telecomunicación
Universitat Politècnica de València,
Camí de Vera, València, 46022 Spain
jgarrigu@eln.upv.es

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Abstract

In this work, the hypothesis that the universe is made up of 4-dimensional spheres of space, whose diameter is the Planck length, allows us to calculate most of the constants used in current physical theories. Calculated constants include: elementary charge, fine structure constant, electron mass, Planck constant, gravitational constant, electrical constant, Boltzmann constant, mass and charge of up and down quarks, mass of second generation quarks: strange and charm, muon mass, Z boson mass and Higgs boson mass. All of them depending on the speed of light and the Planck length, which shows that all the constants are related and not due to chance.

Keywords: Space-time discrete; Fundamental length; Higgs boson mass; Planck length; Mass and charge of up and down quarks; Boltzmann constant; Z boson mass; Gravitational constant; Electrical constant.

1 Introduction

A physical constant is the value of a physical magnitude whose value remains unchanged over time for a given physical process. The fundamental constants form the basis of the most widely accepted physical theories, relativity, quantum mechanics, and the standard model. According to Duff *et al.* “... we defined as fundamental those constants which cannot be calculated at our present level of fundamental knowledge (or rather ignorance).” [1]

The fundamental constants appear in the description of the phenomena of nature. For example, Newton's law of gravitation says that the force between two masses is directly proportional to the product of the masses and inversely proportional to the square of the distance, with G being the constant of proportionality. The speed of light c appears in the special and general theory of relativity and in Maxwell's equations, which are the basis of electromagnetic waves. Planck's constant h appears in quantum mechanics and the mass of elementary particles in the standard model of particle physics.

In the standard model, elementary particles are classified into two groups: bosons and fermions. Bosons have integer spin (0, 1 or 2) and are the particles that interact with matter, while fermions have half-integer spin (1/2 or 3/2) and are the particles that make up matter. Fermions are divided into two groups: quarks that are always in the presence of other quarks, and leptons that can exist in isolation. In the standard model we have 3 types of massive leptons: electron, muon and tau, all with the same negative charge and each with its corresponding neutrino. There are also 6 types of quarks, 3 of them with a positive charge of +2/3 of the charge of the electron and 3 with a negative charge of -1/3 of the charge of the electron: up, down; charm, strange; top, and bottom. The masses of these 12 leptons cannot be calculated, which gives rise to 12 fundamental constants. The W and Z bosons also have their masses. Finally, there is the Higgs boson, which gives mass to the other particles and therefore is a very important part of the theory, with which we obtain another mass or fundamental constant.

The fundamental constants have been measured with great precision and are therefore suitable for defining the units. However, the constants remain enigmatic. For example, the fine structure constant has baffled physicists since its discovery 100 years ago. In general, the values of the fundamental constants are unexplained. “Of course, no one had any idea why they took the particular numerical value that they did.” [2]

“The launch in 2019 of the new international system of units is an opportunity to highlight the key role that the fundamental laws of physics and

chemistry play in our lives and in all the processes of basic research, industry and commerce." [3] In this way, all base units are associated with the rules of nature to create our measurement rules.

If we used different units, the numerical values would be different, therefore, although they provide us with information about nature, they are actually human artifacts that have nothing to do with the Universe. Or put another way, the Universe only needs two constants, which are: the speed of light and the Planck length. All the other constants are necessary for applied physics or for technological development, but they are not necessary to understand the workings of the Universe.

The dimensional constants are used to relate the different constants to each other. For example, the speed of light can be used to convert units of time (such as years) to units of length (such as light years) or vice versa. It also relates the electric (ϵ_0) and magnetic (μ_0) field constants in a vacuum. Therefore, of the 3 constants, only 2 are independent.

According to Baez, *"but most physicists would prefer to have none. The goal is to come up with a theory that lets you calculate all these constants, so they wouldn't be "fundamental" any more. However, right now this is merely a dream.*" [4] In the standard model there is no way to calculate these constants, because it starts from the observation of the phenomena and therefore, its values are known by measuring them over and over again in different physical phenomena.

"Some physicists believe that at least some of the fundamental constants are just cosmic accidents, fixed by the dynamics of the Big Bang. Thus the constants are arbitrary, depending on details of the Big Bang. Obviously in this case there is no way to calculate the fundamental constants." [5]

"The multiplicity and variety of fundamental constants are esthetic and conceptual shortcomings in our present understanding of foundational physics." [6]

"Despite their perceived fundamental nature, however, there is no theory of the constants as such. For example, there is no generally accepted formalism that tells us how the constants originate, how they relate to one another, their relative sizes, or how many of them are necessary to describe physics." [7]

For Duff, the dimensional constants, such as \hbar , c , G , e , k , are human constructions that do not vary in time. *"Dimensional constants, on the other hand, such as, \hbar , c , G , e , k . . . , are merely human constructs whose number and values differ from one choice of units to the next. In this sense only*

dimensionless constants are “fundamental.” Similarly, the possible time variation of dimensionless fundamental “constants” of nature is operationally well-defined and a legitimate subject of physical enquiry. By contrast, the time variation of dimensional constants such as c or G on which a good many (in my opinion, confusing) papers have been written, is a unit-dependent phenomenon on which different observers might disagree depending on their apparatus.” [8]

2 Discrete Space-Time

One of the main objections to discrete space-time is that the existence of a discrete space-time atom is incompatible with the contraction of length and the time dilation of special relativity. However, it must be borne in mind that for lengths and times close to the Planck scale, the Pythagorean theorem is not verified. Therefore, some authors use a modified distance formula. [9-12] Specifically, Crouse and Skufca derive the relativistic phenomena of Lorentz-Fitzgerald contraction and time dilation using a modified distance formula that is appropriate for discrete spaces. They “*show that length contraction of the atom of space does not occur for any relative velocity of two reference frames. It is also shown that time dilation of the atom of time does not occur.*” “... *It was shown that when applied to distances near the Planck scale, the new formula yields distances much different than those predicted by the Pythagorean theorem. But for larger length scales, the distances calculated with the new formula converge to those calculated using the Pythagorean theorem. When using the new distance formula in the otherwise typical derivations of time dilation and length contraction, one sees that the atom of space and atom of time are indeed immutable - true constants of nature and independent of the speed of any observer.*” [13]

According to general relativity, space-time is continuous. However, there is no experimental evidence for this. Are space and time a continuum or are they composed of indivisible discrete units? We're probably convinced of continuity as a result of education. In recent years however, both physicists and mathematicians have asked if it is possible that space and time are discrete? Smolin states that space is formed from atoms of space: “*If we could probe to size scales that were small enough, would we see atoms of space, irreducible pieces of volume that cannot be broken into anything smaller?*” that he calls “Atoms of Space and Time.” [14]

For Heisenberg, the mass of the particles must be derived from a fundamental length, together with the Planck h constant and the speed of light. [15-16]

For some physicists, such as Hawking and Motz, Planck particles could be micro-black holes. [17-19] The mass of Planck has also been proposed as responsible for dark matter. [20, 21]

The Planck scale appears to combine gravity (G), quantum mechanics (h), and special relativity (c). [22] According to Padmanabhan, the Planck length is the minimum length in any space-time. Padmanabhan shows that the Planck length provides a lower limit of length in any suitable physical space-time [23]. *"It is impossible to construct an apparatus which will measure length scales smaller than Planck length. These effects exist even in flat space-time because of vacuum fluctuations of gravity."* [24]

Planck's length can be considered as the shortest distance having any physical meaning. *"...a fundamental (minimal) length scale naturally emerges in any quantum theory in the presence of gravitational effects that accounts for a limited resolution of space-time. As there is only one natural length scale we can obtain by combining gravity (G), quantum mechanics (h) and special relativity (c), this minimal length is expected to appear at the Planck scale."* [25]

Haug proposed different methods of measuring the Planck length independently of the gravitational constant G . The Planck length is both a physical measurement and the diameter of the true fundamental particle: *"The gravitational constant is a composite (derived) constant, while the Planck length represents something physical; it is the shortest reduced Compton wavelength possible. According to recent developments in mathematical atomism, there are also strong indications that the Planck length is the diameter of the only truly fundamental particle, namely an indivisible particle that together with void is making up all matter and energy."* [26]

On the other hand, Haug raises the hypothesis that Heisenberg's uncertainty principle collapses on the Planck scale. [27, 28] The search for a quantum theory of gravity leads to a generalisation of the Heisenberg uncertainty principle (GUP) on the Planck scale. Adler uses Newtonian and general relativistic gravity and modifies the uncertainty principle with an additional term. *"In both theories it is clear that the extra term must be proportional to the energy or momentum of the photon, so on purely dimensional grounds the order of magnitude of the extra term is uniquely determined. As a consequence there is an absolute minimum uncertainty in the*

position of any particle such as an electron. Not surprisingly the minimum is of order of the Planck distance. In view of the absolute minimum position uncertainty one may plausibly question whether any theory based on shorter distances, such as a space-time continuum, really makes sense.” [29] Other authors also conclude that on the Planck scale the fluctuations are of the same order of magnitude as the distances involved. [30, 31]

For Santilli, space must be a solid and incompressible medium. Being also the means of transmission of waves and forces. Matter is a dynamic modification of space. “Space, that must transmit waves and forces, must be full, and matter, which must be a dynamic state of this space – because it interferes and generates forces – must be ‘empty in relation to common concepts’. If we could stop all its movements for a moment, matter would disappear completely, as it actually does, whenever corpuscular radiation interferes.” [32]

3 Four-Dimensional (4D) Discrete Space-Time

The starting hypothesis is that the universe is made up of spheres with 4 spatial dimensions whose diameter is the Planck length. Of the 4 spatial dimensions, 3 are observed as space and the fourth spatial dimension is observed as time ($u=ct$). This is due to the fact that we lack references to the fourth dimension as a consequence of the expansion of the universe. Planck's four-dimensional spheres are atoms of space and time that Smolin comments, [14] To simplify the drawing (Figure 1), only three dimensions are considered: $r(x,y)$ and u .

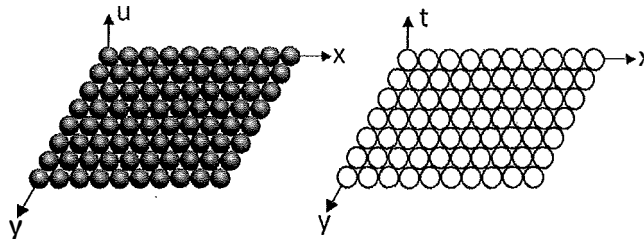


Figure 1. An expanding flat 3D universe is seen as 2D and t

If space is made up of 4D Planck-sized spheres, each Planck sphere can only be at rest or spinning on itself. Furthermore, the 4D Planck sphere has two possible rotations, one from the three-dimensional space and one from the

fourth dimension. Rotation of the fourth dimension (ω_u) rotates the u-axis and another spatial axis about any two axes. For example, the u-y axes rotate around the x-z axes. In the rotation of space (ω_e) it is rotated around the axis u and another spatial axis. For example, the x-z axes rotate around the u-y axes. Therefore the 4D Planck sphere can rotate both 3D space and the fourth dimension ($u = ct$, Figure 2), which results in the following combinations

- zero rotations. Vacuum space;
- one spatial rotation, ω_e . Photons;
- one rotation of the fourth dimension ω_u . Gives rise to neutrinos;
- 2 rotations, one of the space ω_e and another of the fourth dimension ω_u . Electron, positron and quarks up and down.

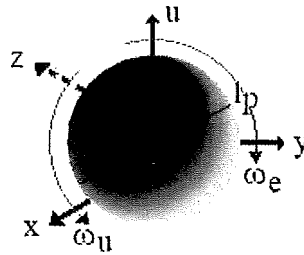


Figure 2. Rotations of a 4D Planck sphere

The static spheres of space are not observed, it is what we call empty space. The spinning spheres are observed as elementary particles, such as electrons, photons, first generation quarks and neutrinos. The 4D Planck sphere is determined by only two constants: Planck length and speed of light.

These spheres constitute a solid and incompressible space that transmits the waves. *"Since space transmits waves and forces, it is absurd to assume that it is empty, whereas it must be a solid, incompressible medium. And the elementary particles, since they interfere and generate forces, can by no means have a ponderable nature, but must be active energy states determined by a dynamic state of space points."* [32]

Those spheres are the fundamentally grainy nature of space that comments Das et al. *"We again arrive at quantization of box length, area and volume and an indication of the fundamentally grainy nature of space."* [33]

In causal set theory, space-time is made up of identical space-time atoms with no internal structure. [34-37]. *“According to this proposal, spacetime is comprised of discrete “spacetime atoms” at the Planck scale.”* [34] Also T. Padmanabhan describes gravity from atoms of space-time [38].

T. P. Sing proposes a New Quantum Theory of Gravity based on space-time atoms in such a way that each atom has its own matter content. *“In our theory, the universe is made up of enormously many such atoms of space-time-matter (STM). We do not know at this stage as to what determines the total number of such STM atoms in the universe, and whether this total number is finite or infinite. Each STM atom carries its own space-time and its own matter content.”* [39] It also uses the Planck length and speed of light as fundamental constants. *“The theory is in fact a classical matrix dynamics with only two fundamental constants – the square of the Planck length and the speed of light, along with the two string tensions as parameters.”* [39]

4 Speed of Light c

The speed of light depends on two parameters: length and time. The unit of length is the meter and it is defined as one ten-thousandth of the distance between the north pole and the equator. The unit of time is the second which is defined from a fraction of the day. Therefore, the numerical value of the speed of light depends on the arbitrariness of the definitions of length and time. Currently the meter is defined as the distance that light travels in a vacuum in an interval of $1/299792458$ s. In this way, the speed of light becomes a fundamental constant that cannot be calculated, but is defined exactly and whose value is $c = 299792458$ m/s. [40]

If we make $c = 1$, it results:

$$299\,792\,458 \text{ m/s} = 1 \quad (1)$$

Thus,

$$1 \text{ s} = 299\,792\,458 \text{ m} \quad (2)$$

5 The Origin of the Constants

In current physics, space-time is continuous, which implies that in principle the constants are arbitrary and due to chance. However, in a discrete space-time, the sphere of 4D space will have a certain size and whose diameter will be a function of the unit of length. That sphere is the one that will determine the origin of the constants

5.1 The Origin of the Gravitational Constant G

The universal gravitational constant G determines the intensity of the force of gravitational attraction between objects. It is a physical constant obtained empirically and whose value is, $G = 6.67430 \times 10^{-11} \text{ m}^3/\text{kg s}^2$. [40]

If we make $G = 1$, it results:

$$6.67430 \times 10^{-11} \text{ m}^3/\text{kg s}^2 = 1 \quad (3)$$

From where,

$$1 \text{ kg} = 6.67430 \times 10^{-11} \text{ m}^3/\text{s}^2 \quad (4)$$

It must be remembered that in 1795, during the French Revolution, the gram was used as the mass of one cubic centimeter of distilled water at one atmosphere of pressure and at a temperature of 3.98 °C, corresponding to the melting point of ice. The basic unit of mass in the International System of Units is the kilogram, which corresponds to one liter of water. But because the density of water varies with atmospheric pressure, a standard mass is used as a reference. This standard mass is made up of a cylinder of platinum and iridium (90% and 10%, respectively), which is kept at the International Bureau of Weights and Measures (BIPM) in Sèvres, near Paris.

A volume of water is arbitrarily chosen and the unit of mass is assigned to it. But the same volume of water can also be assigned the value of $6.674 \times 10^{-11} \text{ kg}$. In this way it turns out that $G = 1 \text{ m}^3/\text{kg s}^2$. Also, if we assign the value of $6.674 \times 10^{-11} \text{ m}^3/\text{s}^2$ to that liter of water, the gravitational constant and the kilogram of the international system disappear. Table I shows the values and units of G as a function of the values and units of mass.

Table I. Values and units of G depending on the values and units of mass.				
Volume of water	Mass	Units of mass	Value of G	Units of G
1 liter	1	kg	6.67430×10^{-11}	$\text{m}^3/\text{kg s}^2$
1 liter	1	m^3/s^2	6.67430×10^{-11}	-----
1 liter	6.67430×10^{-11}	kg	1	$\text{m}^3/\text{kg s}^2$
1 liter	6.67430×10^{-11}	m^3/s^2	-----	-----

If we had assigned a value of 1 kg to a liter of oil, the gravitational constant would have a slightly different value. Therefore, the value of the gravitational constant is determined by our arbitrary choice of the units of length, mass, and

time. By fixing the meter as the unit of length, the value of the Planck length (l_p) is also fixed. By setting the second as the unit of time, the value of the speed of light (c) is determined. This results in:

$$l_p c^2 = 1.453 \times 10^{-18} \text{ m}^3/\text{s}^2 \quad (5)$$

By creating the concept of mass from 1 liter of water, the value of the Planck mass (m_p) is determined and the product $l_p c^2$ is separated into two constants.

$$(l_p c^2/m_p) m_p = G m_p \quad (6)$$

This also creates the Gravitation constant dependent on the speed of light and Planck units of length and mass.

$$G = l_p c^2/m_p \quad (7)$$

A liter of water is the volume that we observe. Today we know that not all the volume is occupied. We also know that the particles that make up that volume move, then,

$$1 \text{ dm}^3 \text{ de agua} = 6.674 \times 10^{-11} \text{ m}^3/\text{s}^2 \quad (8)$$

If now, we make that liter of water equal to 1 Kg, we have created the value of G . In short, G is a human construction. Table II shows the units of mass, force and gravitational constant in the International System (IS).

Table II. Units of mass, force and gravitational constant in the IS				
International System	Symbol	Value	Units	Dimensions
Mass	m	1	kg	M
Gravitation Constant	G	6.67430×10^{-11}	$\text{m}^3 \text{ kg}^{-1} \text{ s}^{-2}$	$\text{L}^3 \text{ M}^{-1} \text{ T}^{-2}$
Force	F	1	kg m s^{-2}	L M T^{-2}

L = length; M = mass, T= time, kg = kilograms, m = meters and s = seconds

For Matsas et al., there are only two fundamental constants: length and time. To do this, multiply by G , the mass and Planck's constant. Thus G plays the role of a conversion factor (from grams to cm^3/s^2) in the same way as Boltzmann's constant k (from ergs to Kelvin). [41] We can make the following change:

$$m' = G m \quad (9)$$

$$F' = G F \quad (10)$$

$$h' = G h \quad (11)$$

With which the gravitational constant G is no longer necessary and the kilogram disappears from the International System of Units. By fixing the meter as the unit of length, the value of the Planck length (l_p) is also fixed. By setting the second as the unit of time, the value of the speed of light (c) is determined. Which results: $m'_p = l_p c^2$. If now, we make that liter of water equal to 1 Kg, the value of the Planck mass (m_p) is fixed in such a way that the natural unit of mass $m'_p = l_p c^2$, is separated into two constants, namely : gravitational constant G and Planck mass m_p .

$$G = l_p c^2 / m_p \quad (12)$$

This brings up the kilogram and the gravitational constant. If we use m' ($m' = Gm$) instead of m , all measurements in physics reduce to measurements of space and time. In this way, G disappears from all physical equations, thus reducing the number of dimensional fundamental constants.

"One can use $M' = GM$ instead of M in order to reduce all measurements in physics to measurements of space and time intervals and exorcise G from all equations of physics, thus reducing the number of fundamental dimensional constants." [42]

Januz Kowalski, on the other hand, comes to a similar conclusion and deduces the mass as a function of the Planck length. [43]

In the same way that mass is a form of energy, the new definition of mass, m' , is also a form of energy, governed by the same equation, but only with units of length L and time T .

$$E' = GE = Gmc^2 = m'c^2 [L^5, T^4] \quad (13)$$

5.2 The Origin of Planck's Constant h

Planck's constant was proposed as a proportionality constant between the frequency of the electromagnetic wave associated with the photon and its energy. It depends on the units of length, mass and time chosen, being its value $h = 6.62607015 \times 10^{-34} \text{ kg m}^2/\text{s}$. [40] In the Planck units of length, mass and time the reduced Planck constant is used, then,

$$\hbar = m_p l_p c = 1.0545718171 \times 10^{-34} \text{ kg m}^2/\text{s} \quad (14)$$

For Duff [44] and Volovik [45] \hbar is a fundamental constant and therefore can be used as an energy-to-frequency conversion factor.

If we express mass as a function of length and time (equation (4)), the new value of Planck's natural constant turns out to be:

$$\hbar' = G \hbar = l_p^2 c^3 = 7.038 \times 10^{-45} \text{ m}^5/\text{s}^3 \quad (15)$$

Which depends only on the Planck length and the speed of light and is therefore determined. Applying the same force to objects with the same volume produces different accelerations. To distinguish some objects from others, the concept of mass is created (Newton's second law). This results in the product $l_p c^2$ splitting into two new constants G and m_p . In turn, the product $l_p^2 c^3$ is also separated into two constants: gravitational constant and Planck's reduced constant.

$$\hbar' = l_p^2 c^3 = (l_p c^2 / m_p)(m_p l_p c) = G \hbar \quad (16)$$

The $(m_p l_p c)$ gives rise to Planck's reduced constant or angular momentum. Since all particles rotate (m^3/t^2), the energy in a period will be an integer or half-integer multiple of Planck's constant. That is, we have converted the turn into a constant. However, the spin (rotation) of the particles is not observed due to our technological limitations. What is observed is the period or wavelength. The energy will be:

$$E' = GE = G\hbar\omega = \hbar'\omega \quad (17)$$

As before, if we use $\hbar' = G \hbar$ instead of \hbar , all measurements in physics reduce to measurements of space and time. In this way, \hbar also disappears from all physical equations, thus reducing the number of dimensional fundamental constants. In short, the units of \hbar will depend on the unit chosen for the mass, in addition to the units of length and time.

Like the constant of gravitation, it is the arbitrary definition of the kilogram that prevents the calculation of Planck's constant \hbar , unless a boundary condition is imposed.

5.3 The Origin of the Electric ϵ_0 and Magnetic μ_0 Constants

2,500 years ago, the Greeks already knew that by rubbing an amber stone, it attracts small objects such as feathers and straw. To differentiate this force from the gravitational force, the concept of electric charge is created. Since the force can be attractive or repulsive, then the electric charge must be positive or negative. The unit of electric charge is the coulomb, which derives from the ampere and is defined as the amount of charge transported in one second by an electric current of one ampere of intensity. Therefore, the intensity (I) of electric current can be expressed as the number of coulombs (Q) per unit of time (t), $I = Q / t$. Thus, the constant of Coulomb's law is equal to, $K=9.98755179 \times 10^9 \text{ m}^3\text{kg/s}^2\text{C}^2$. If we make $K = 1$ it results:

$$K = 9.98755179 \times 10^9 \text{ m}^3\text{kg/s}^2\text{C}^2 = 1 \quad (18)$$

Thus,

$$1 \text{ C} = \sqrt{9.98755179 \times 10^9 \text{ m}^3 \text{ kg} / \text{s}^2} \quad (19)$$

Therefore, the coulomb depends on the units of length, mass, and time. If we take into account equation (4), it turns out that:

$$1 \text{ C} = \sqrt{8.98755179 \times 10^9 \times 6.67430 \times 10^{-11}} = 7.74503 \times 10^{-1} \text{ m}^3 / \text{s}^2 \quad (20)$$

Which indicates that the Coulomb's law constant is simply a conversion factor, which needs to be introduced into the equation to preserve the units on both sides of the equation. Therefore, the coulomb, like the kilogram, can be expressed in units of length and time. On the other hand, in the same way that we have multiplied the mass by the gravitational constant, which is equivalent to multiplying the gravitational force by G , we multiply the Coulomb force by G , with which.

$$F'_C = GF_C = GK \frac{q^2}{r^2} \quad (21)$$

Under Planck conditions, the gravitational force and the Coulomb force are equal. Therefore,

$$F'_p = GF_p = G^2 \frac{m_p^2}{l_p^2} = GK \frac{q_p^2}{l_p^2} \quad (22)$$

Being K the constant of Coulomb's law and q_p the Planck charge, then,

$$Gm_p = \sqrt{GK} q_p = l_p c^2 \quad (23)$$

When defining the electrical charge from the current of one ampere, the value of the Planck charge (q_p) is fixed, so that the product $l_p c^2$ is separated into two new variables q_p and $(GK)^{1/2}$. Since the value of G is already defined, it turns out that the new constant can be put as:

$$K = \frac{l_p^2 c^4}{G q_p^2} \quad (24)$$

And taking into account equation (7) it results:

$$K = \frac{l_p c^2}{q_p^2} m_p \quad (25)$$

Where the values of Planck mass (m_p) and Planck charge (q_p) depend on the definition of mass and electric charge, respectively. The electric field constant will be:

$$\varepsilon_0 = \frac{1}{4\pi} \frac{q_p^2}{m_p l_p c^2} \quad (26)$$

Or as a function of Planck's constant,

$$\varepsilon_0 = \frac{1}{4\pi} \frac{\hbar^2}{m_p l_p^2 c} \quad (27)$$

The electric and magnetic field constants are related by the speed of light:

$$\varepsilon_0 \mu_0 = \frac{1}{c^2} \quad (28)$$

Therefore, of the three constants, only one is actually necessary.

6 Units of Mass and Charge

Both mass and charge as well as space and time are fundamental or basic concepts that are difficult to understand. Physicists don't know what mass is. They simply define different ways of measuring something they call mass. In current physics, mass is defined as the amount of matter in a body. Mass is a fundamental physical quantity that expresses the inertia or resistance to change in the movement of a body. It is an intrinsic property of particles.

Current physics does not explain what electric charge is either, but simply establishes a unit of charge or reference, corresponding to the electric charge of the electron. If we make the following change:

$$m' = \frac{Gm}{c^2} \quad (30)$$

mass now has units of length [L]. However, this way of proceeding changes the numerical values to which we are accustomed. In order not to change the numerical values and to be able to calculate the fundamental constants, [46, 47] the following change can be made:

$$m' = \frac{G_1}{c_1^2} m \quad (31)$$

Where $G_1 = 1 \text{ m}^3 / \text{kg s}^2$ y $c_1 = 1 \text{ m/s}$. In this way, the unit constant $G_1 / c_1^2 = 1 \text{ m/kg}$ transforms kilograms into meters and vice versa. In this way, the mass retains its numerical value, however the unit of measurement changes. The force will now have speed units squared, that is:

$$F' = \frac{G_1}{c_1^2} F \text{ m}^2/\text{s}^2 \quad (32)$$

Also the gravitational constant retains its numerical value, but its units change.

$$G' = \frac{c_1^2}{G_1} G \text{ m}^2/\text{s}^2 \quad (33)$$

Planck's constant will be:

$$h' = \frac{G_1}{c_1^2} h \text{ m}^3/\text{s} \quad (34)$$

Having units of length squared times speed or area in movement. Therefore, the unit of mass can be the kilogram, the meter, the cubic meter/second squared, or any other combination of space and time. In any case, a constant is necessary so that the units of force in Newton's second law and in the law of universal gravitation coincide.

The arbitrary definition of the kilogram is what prevents the calculation of the gravitational constant, unless a boundary condition is imposed. In addition, when defining the kilogram as a unit of mass, the constant of gravitation and the constant of Planck are generated depending on the unit of mass, in addition to the units of space and time.

For the electric charge we can make the same change and express the electric charge in meters. But we can also keep in mind that, for a current of one ampere ($I = 1 \text{ C/s}$), we can express the coulombs in seconds. Which is equivalent to making the change:

$$q' = \frac{\sqrt{K_1 G_1}}{c_1^3} q \text{ segundos} \quad (35)$$

Where $K_I = 1 \text{ kg m}^3 / \text{s}^2 \text{ C}^2$. In this way, the unitary constant $\sqrt{G_1 K_1} / c_1^3 = 1 \text{ s/C}$ transforms coulombs (q) into seconds (q') and the charge retains its numerical value. Identical equation to Stoney time: [48]

$$t_s = \frac{\sqrt{KG}}{c^3} e \quad (36)$$

Where e is the charge of the electron. It should be noted that the inverse of this unit constant is what we call amps. Coulomb's constant will now have units of speed raised to the fourth power.

$$K' = \frac{c_1^4}{K_1} K \text{ (metros/segundos)}^4 \quad (37)$$

And the Coulomb force will be:

$$F'_C = \frac{G_1}{c_1^2} F_C = \frac{G_1}{c_1^2} K \frac{q^2}{r^2} \text{ (metros/segundos)}^2 \quad (38)$$

The units of the electric field will be:

$$E' = K' \frac{e'}{r^2} \text{ metros}^2/\text{segundos}^3 \quad (39)$$

Which correspond to the units of frequency, multiplied by a speed squared. The intensity of the current in amperes becomes dimensionless. Therefore, the load can be expressed in m^3/s^2 according to the equation ($1 C = 24.508 m^3/s^2$) or in seconds for the current of one ampere or if the corresponding change of variables is made (equation (35)). Ultimately, all constants can be expressed in units of length and time

7 Relationship Between Mass and Charge of Electron

Suppose we have a particle of mass m , which rotates at speed ω_e , the potential of the gravitational field at distance r will be:

$$\frac{Gm}{r} = v^2 \quad (40)$$

where G is the gravitational constant, and v is the linear speed of rotation of the particle.

The Planck sphere rotates one complete revolution in three-dimensional space (ω_e) at the same time that it rotates the fourth dimension (ω_u), so that the particle is upside down ($\omega_e = 2 \omega_u$), which we see as spin $\frac{1}{2}$. [49]

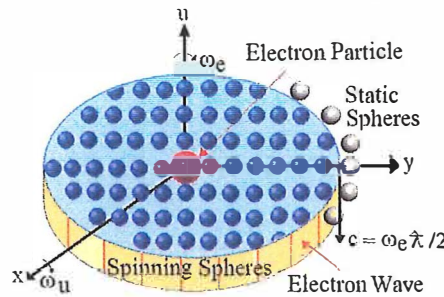


Figure 3. Two-dimensional representation of the electron

The 4D Planck spheres are linked by the Planck force, so rotating one of them will drag it to the adjacent spheres. The linear speed of rotation (Figure 3) will increase as we move away from the rotating sphere, until the speed of light c is reached at a distance r , then,

$$v = \omega_u l_p \quad c = \omega_u r \quad (41)$$

The rest mass is due to rotation in the fourth dimension (ω_u), while the wave is due to rotation in space (ω_e) or disturbance in a medium. Said medium is formed by the static 4D Planck spheres that constitute empty space.

Assuming that the gravitational field potential (equation (40)) of a particle of mass m is equal to the square of the linear velocity of rotation ($v = \omega_u l_p$) of a Planck sphere, as shown in (Figure 4), we have that:

$$\frac{Gm}{r} = v^2 = (\omega_u l_p)^2 \quad (42)$$

Substituting $c = \omega_u r = \omega_u \lambda$ in equation (42), and taking into account the Planck length $l_p = \sqrt{G\hbar/c^3}$, we obtain:

$$E = mc^2 = \frac{1}{2} \hbar \omega_e = \hbar \omega_u = \frac{\hbar c}{r} = \frac{\hbar c}{\lambda} \quad (43)$$

where \hbar is the reduced Planck constant, r is the distance in the fourth dimension that adjacent spheres of space and time rotate at the speed of light and coincide with the wavelength of the electron $\lambda = \lambda/2\pi$. Therefore, the energy ($\hbar \omega_u$) of the rotation of the Planck sphere in the fourth dimension (ω_u) is what we call mass, and the square of the linear speed of rotation of the Planck sphere is what we call the potential of the gravitational field. [50, 51]

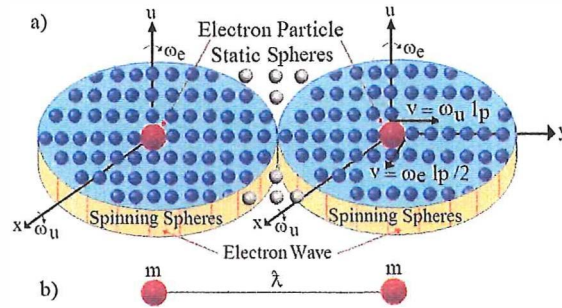


Figure 4. a) Discrete space. b) Continuous space.

On the other hand, suppose we have a circular loop carrying an electric current I . Let us also say that we gradually reduce the loop until we reach the Planck size ($lp \approx 10^{-35}$ m) and that the electric current flowing is equal to 1A. Under these conditions, the coulomb, which is the arbitrary unit of electric charge, coincides with the time in seconds that it takes for the particle to make one revolution.

Under these conditions, the period of rotation in the fourth dimension gives rise to the electric charge. The mass will be due to the rotational energy of the 4D Planck sphere. This allows us to relate the mass and electric charge of the electron by applying the Heisenberg uncertainty principle [49-52] as a certainty principle.

$$E = mc^2 = \frac{1}{2} \hbar \omega_e = \hbar \omega_u \quad (44)$$

The mass m is what we call rest mass or inertial mass. Equation (43) can be expressed in terms of the period ($\omega_u = 2\pi T_u$), with which:

$$E = mc^2 = \frac{1}{2} \frac{h}{T_e} = \frac{h}{T_u} \quad (48)$$

The electric charge will be due to the rotation ω_u (one of the three possible rotations). Therefore, the electric charge can be expressed as:

$$q = \frac{1}{cr^2} \cdot \frac{\partial V_{4D}}{\partial u} = 2\pi^2 T_u \quad (49)$$

And substituting the period for the electric charge in equation (48) we get:

$$E = mc^2 = \frac{2\pi^2 h}{q} \quad (50)$$

Where m is the rest mass of the electron and the electric charge q is in seconds. If we want to preserve the units we are used to, simply undo the change (equation (35) or multiply by the current of one ampere ($I = 1$ A).

$$E = mc^2 = \frac{2\pi^2 h}{q} I \quad (51)$$

Therefore, Planck's constant relates the mass and charge of the electron.

8 Calculation of the Fundamental Constants

Both mass and electric charge can be expressed in units of space and time. Therefore, the fundamental units are two: length and time. On the other hand,

my hypothesis is that the universe is made up of four-dimensional spheres of space, whose diameter is the Planck length. Therefore, the fundamental units would be Planck length and Planck time. However, as the Planck length has not yet been measured, but is calculated from other constants ($l_p = \sqrt{G\hbar/c^3}$), among which is the Gravitation constant G .

Since G is extremely small and is measured with very little precision, it is convenient to choose the reduced Compton wavelength of the electron as the constant linked to the unit length. On the other hand, we can link the speed of light c to the unit of time, instead of the Planck time, because the speed of light relates space and time and the Planck time has not been measured either.

Since mass and electric charge can be put in units of space and time, they can be calculated fairly accurately, by establishing a boundary condition, from the speed of light and the Compton wavelength of the electron. In short, taking into account equations (31) and (35) we can express and calculate the mass in meters and the load in seconds.

8.1 Calculation of the Elemental Charge

Electric charge is an electromagnetic constant and is measured in coulombs in honor of Charles-Augustin de Coulomb, for his mathematical description of the law of attraction between electric charges. Its value is, $1.021766208 \times 10^{-19}$ C. [40]

It has been seen that the electric charge is due to the period of rotation of the fourth dimension ω_u (one of the three possible rotations). Therefore, the electric charge can be expressed as:

$$q = \frac{1}{cr^2} \frac{\partial V_{4D}}{\partial u} = 2\pi^2 T_u \quad (52)$$

The period can be expressed as a function of wavelength, as:

$$\lambda = cT_u \quad (53)$$

Substituting T_u in equation (52) gives:

$$q = 2\pi^2 \frac{\lambda}{c} = 1.59755 \times 10^{-19} \text{ s} \quad (54)$$

Where the electric charge is in seconds according to the change made (equation (35)). If you want the charge in coulombs, just undo the change (or multiply the above equation by one amp ($I = 1$)). [49]

$$q = 2\pi^2 \frac{\lambda}{c} I = 1.59755 \times 10^{-19} \text{ C} \quad (55)$$

The relative error is $2.89 \cdot 10^{-03}$. It seems appropriate to state that current physics does not know what electric charge is nor why it has that value. A coulomb is an arbitrary unit of electric charge. Current theory allows electric charge to be measured but not explained. Simply, electric charge is defined as an intrinsic or fundamental property of matter.

8.2 Calculation of the Fine Structure Constant

The fine structure constant was introduced by Arnold Sommerfeld in 1920, to explain the hyperfine splitting of atomic spectral lines. Since then there have been many attempts to find approximate formulas based on purely algebraic relationships. Since the fine structure constant relates the electric charge, Planck's constant, the electric field constant and the speed of light, it will be necessary to calculate these constants.

The fine structure constant characterizes the electromagnetic interaction, included in the atomic and nuclear category. Its value is, $\alpha = 7.2973525664 \times 10^{-3}$. [40]

The charge is the period or time it takes for the particle to make one revolution. Mathematically it would be:

$$q = \pi T_e = \pi \frac{T_u}{2} \text{ (segundos)} \quad (56)$$

The energy of this rotation can be calculated simply by applying Heisenberg's uncertainty principle as a certainty principle.

$$E_J = \frac{1}{2} \frac{\hbar}{T_e} \quad (57)$$

Being T_e the period of rotation around the fourth dimension. In the quantum model, the standing wave that constitutes the electron is given by the De Broglie wavelength, however, if we take the wavelength as a function of Planck's reduced constant, which is the one involved in the principle of Heisenberg uncertainty, it turns out:

$$\lambda_B = \frac{1}{\alpha} \frac{\hbar c}{mc^2} \quad (58)$$

And taking into account equation (50) it results:

$$\lambda_B = \frac{1}{2\pi\alpha} \frac{qc}{2\pi^2} \quad (59)$$

And depending on the rotation period, equation (56):

$$\lambda_B = \frac{cT_e}{4\pi^2\alpha} \quad (60)$$

And substituting in equation (57), it results:

$$E_J = \frac{1}{8\pi^2\alpha} \frac{\hbar c}{\lambda_B} \quad (61)$$

And imposing the condition that the Planck energy at the distance $r = \lambda_B$, is equal to the spin energy in that direction, it turns out:

$$E_{J,r} = \frac{E_J}{\sqrt{3}} = \frac{\hbar c}{\lambda_B} \quad (62)$$

From where,

$$\alpha = \frac{1}{8\pi^2\sqrt{3}} = 7,312 \times 10^{-3} \quad (63)$$

The geometric interpretation is as follows: The 4π is due to the surface of the three-dimensional sphere that is observed. The 2π is due to the rotation of that sphere in three-dimensional space, that is, 2π radians. Finally, the $\sqrt{3}$ is due to the diagonal of the unit cube in Cartesian coordinates.

Dănescu obtains the same expression and a similar geometric interpretation through dimensional analysis. Three relations of the 16 analyzed by Danescu, lead to the same expression of the fine structure constant, only as a function of the geometric constants analyzed. [53, 54]

Feynman wrote about the fine structure constant. *"It has been a mystery ever since it was discovered over fifty years ago, and all good theoretical physicists put this number on their wall and worry about it..... Immediately you would like to know where this number for a coupling comes from: is it related to π or perhaps to the base of the natural logarithms? Nobody knows. It's one of the greatest damn mysteries of physics: a magic number that comes to us without understanding by man."* [55]

8.3 Calculation of Planck Length

Although the Planck length is not properly a fundamental constant, but derived from other fundamental constants, it will be necessary to calculate the mass of the electron in meters and the Gravitation constant. The Planck length is given by:

$$l_P = \sqrt{\frac{G\hbar}{c^3}} \quad (64)$$

The Planck length can be calculated since there is a relation to the reduced Compton wavelength of the electron, which we have taken as the length constant. But for this, it is necessary to establish a boundary condition, or unitary element. We start from a 4D Planck sphere that rotates at the Planck speed of rotation. Said Planck sphere reduces its speed of rotation until it reaches the minimum value of rotation, which gives rise to the electron. The minimum acceleration corresponds to the rotating central sphere, then,

$$a_{\min} = \omega_e^2 \frac{\lambda_p}{2} \quad (65)$$

On the other hand, the speed of the electron in the free state is αc [49] and the acceleration corresponding to that speed will be:

$$a = 4\pi \frac{\alpha c}{\sqrt{2}t} \quad (66)$$

The 4π is due to the two turns that the electron must make to return to the initial state (spin $\frac{1}{2}$). The $\sqrt{2}$ is due to the diagonal of the square of unit side ($t=1s$), whose sides are the three-dimensional space $r(x,y,z)$ and the fourth dimension u .

And taking into account the value of the fine structure constant already calculated (equation (63)), it results:

$$\frac{4\pi c}{8\pi^2 \sqrt{3}} \frac{1}{\sqrt{2}t} = \omega_e^2 \frac{\lambda_p}{2} \quad (67)$$

From where,

$$\lambda_p = \frac{1}{\pi \sqrt{6}} \frac{c}{\omega_e^2 t} = 1.61595 \times 10^{-35} \text{ m} \quad (68)$$

8.4 Calculation of Electron Mass

If we express the mass in meters (equation (31)) and the charge in seconds (equation (35)), it turns out that the speed of rotation of the electron relates the mass to the charge ($m = q \nu$). On the other hand, under the Planck conditions it is verified,

$$Kq_p^2 = Gm_p^2 \quad (69)$$

where K is the Coulomb constant, G is the constant of gravitation, q_p is the Planck electrical charge and m_p is the Planck mass. Thus,

$$m_p = \sqrt{\frac{K}{G}} q_p = \sqrt{\frac{K}{Gc^2}} q_p c = \frac{1}{\sqrt{4\pi}} \sqrt{\frac{\mu_0}{G}} q_p c = \frac{1}{\sqrt{4\pi}} \frac{q_p c}{\alpha} \quad (70)$$

So α can only be the fine structure constant. The mass of the electron can be put as a function of the Planck mass, through the reduced Compton wavelength of the electron and the reduced Planck constant. Thus,

$$m = \frac{\hbar}{\lambda c} = \frac{m_p l_p}{\lambda} \quad (71)$$

Substituting the Planck mass (equation (70)), and taking into account that the fine structure constant relates the electric charges of the electron and Planck ($\sqrt{\alpha} = q/q_p$), we obtain the following expression for the mass of the electron:

$$m = \frac{1}{\sqrt{4\pi}} \frac{q_p c}{\alpha} \frac{l_p}{\lambda} = \frac{1}{\sqrt{4\pi}} \frac{qc}{\alpha \sqrt{\alpha}} \frac{l_p}{\lambda} \quad (72)$$

Where, the mass of the electron (m) is in meters and the charge of the electron (q) in seconds. The wavelength of the electron can be expressed in terms of the electric charge (Equations (53)), as follows:

Substituting into Equation (72), we obtain the mass of the electron in metres.

$$m = 2\pi^2 \sqrt{\frac{\pi}{\alpha}} \frac{l_p}{\alpha} = 9.086 \cdot 10^{-31} m \quad (74)$$

The mass is the space in the fourth dimension of the 4D Planck sphere, projected onto the 3D sphere that we observe as a particle. To obtain the mass in kilograms, simply undo the change, equation (31). In a universe made only of space and rotation of 4D Planck spheres, if the electric charge is time, the rest mass can only be space.

$$\lambda = \frac{qc}{2\pi^2} = 2\pi\lambda \quad (73)$$

8.5 Calculation of Planck's Constant

Planck's constant is a universal physical constant, its value being: $6.63607015 \cdot 10^{-34} \text{ kg m}^2/\text{s}$ [40]. It represents the elemental quantum of action and relates the amount of energy to the frequency associated with a particle. To calculate Planck's constant we can use the relationship between the mass and charge of the electron, equation (51).

$$h = \frac{1}{I} \frac{qmc^2}{2\pi^2} = 6.6452 \times 10^{-34} \text{ kg m}^2/\text{s} \quad (75)$$

Paul Dirac in 1963 wrote: *"The physics of the future, of course, cannot have the three quantities h , e and c all as fundamental quantities. Only two of them can be fundamental, and the third must be derived from those two. It is almost certain that c will be one of the two fundamental ones. The velocity of light, c , is so important in the four-dimensional picture, and it plays such a fundamental role in the special theory of relativity, correlating our units of space and time, that it has to be fundamental [56].* In fact, the Planck constant has been obtained as a function of e and c , since c and l_p determine the initial conditions of the 4D Planck sphere. Planck's constant \hbar can also be calculated based on the speed of light, Planck length and fine structure constant.

8.6 Calculation of the Gravitation Constant

The gravitational constant G depends on the speed of light, the reduced Planck constant and the Planck length, therefore we need the value of the Planck length. Value that has been calculated previously based on the reduced Compton wavelength of the electron, which we have taken as the length constant. So the gravitational constant will be:

$$G = \frac{\lambda_p^2}{\hbar} c^3 = 6.67174 \cdot 10^{-11} \text{ m}^3 \text{kg}^{-1} \text{s}^{-2} \quad (76)$$

Value that falls within the 14 measured values of the Newtonian constant of gravitation G of interest in the 2014 fit. [40]

8.7 Calculation of the Electric Constant

The electrical constant is related to the already calculated constants of: fine structure (equation (63)), charge of the electron (equation (55)) and Planck's constant (equation (75)). In addition to the speed of light.

$$\epsilon_0 = \frac{1}{4\pi\alpha} \frac{q^2}{\hbar c} \quad (77)$$

Being the electric charge in seconds. If you want the electric charge calculated in coulombs, just multiply it by the current of one ampere. Therefore:

$$\epsilon_0 = \frac{1}{4\pi\alpha} \frac{q^2}{\hbar c} I^2 = 8.80168 \times 10^{-12} \quad (78)$$

Which gives a relative error of 5.93×10^{-03} .

8.8 Calculation of the Boltzmann Constant

Boltzmann's constant relates absolute temperature and energy. Its value is: $1.38064852(79) \times 10^{-23} \text{ JK}^{-1}$, with a standard uncertainty of 5.7×10^{-7} . [40]

It has been seen that the energy of the electron is due to the rotation of the fourth dimension. This rotation will have to be projected on the 3 spatial dimensions that are observed. The energy can be put as a function of the Compton wavelength. This energy will have to be equal to the energy given by the temperature.

$$E = \frac{1}{2\pi^2} \frac{hc}{\lambda} = kT \quad (79)$$

The temperature will be due to the rotation of the electron to $c = 1 \text{ m/s}$ y $T=1 \text{ K}$, then:

$$K = \frac{1}{2\pi^2} \frac{h c}{\lambda T} = 1.3835 \times 10^{-23} \text{ JK}^{-1} \quad (80)$$

where: $h=6.626 070 040(81) \times 10^{-34} \text{ Js}$ and $\lambda=2.426 310 2367(11) \times 10^{-12} \text{ m}$.

Which gives a relative error of 0,21%.

8.9 Calculation of Mass and Charge of Down and Up Quarks

The developed model is based on the fact that both the universe and the particles verify Heisenberg's uncertainty principle, as a certainty principle. Therefore, the equation to take into account is Heisenberg's uncertainty principle and obviously not to modify it.

If we place two electrons (positrons), one in the past and one in the future of an electron (positron) positioned in our space-time. In these circumstances, the magnetic fields are oriented in the same direction, therefore there will be attraction between them and thus we will have two ways of combining them. [57]

Equation (50) establishes a relationship, through Planck's constant, between the mass (m) and the charge of the electron (q). This equation can be put:

$$\frac{1}{2\pi^2} n^2 m c^2 \frac{q}{n} = nh \quad (81)$$

Where n and l is positive integer or half-integer, h the Planck constant, m and q the mass and charge of the electron respectively. The mass m_n and the electric charge q_n of the particles will be given by:

$$\begin{aligned} m_n &= n^2 m \\ q_n &= \frac{q}{n} \end{aligned} \quad (82)$$

For $n = 1$, we obtain the mass and the electron electric charge

Down Quark

The electron (positron) positioned in our temporal space acquires the rotations of electrons (positrons) positioned in the past and future (Figure 5), therefore its rotation and angular momentum become three times as much, which creates an electric charge equal to $1/3$ electron (positron) charge. [57]

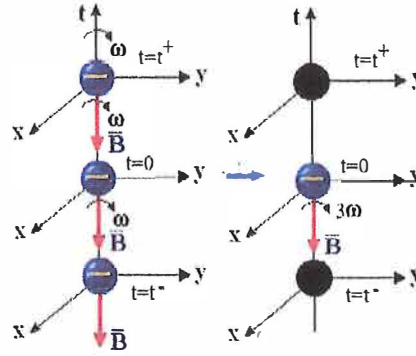


Figure 5. Formation of the Down Quark

For $n = 3$, results in:

$$m_d = 9m = 4.59 \text{ MeV} \quad (83)$$

Value that falls within the limits recommended by PDG, between 4.50 a 5.15 MeV [58]. The electric charge will be:

$$q_d = \frac{1}{3} q \quad (84)$$

Up Quark

The other possibility is that the positron (electron) positioned in our temporal space loses the rotation in a way that positrons (electrons) positioned in the past and in the future acquire half of the rotation (Figure 6), thus their rotation becomes $3/2$ of the positron's (electron's) rotation with an angular momentum equal to three times the angular momentum of the positron

(electron), which creates an electric charge equal to $2/3$ de charge of the positron (electron). [57]

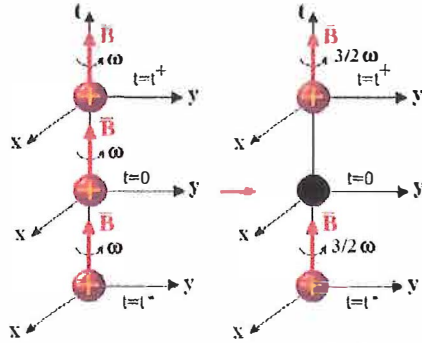


Figure 6. Formation of the Up Quark

For $n = 3/2$, results in:

$$m_u = 2n^2 m = \frac{9}{4} m = 2.30 \text{ MeV} \quad (85)$$

Value that falls within the limits recommended by PDG, between 1.90 y 2.65 MeV. [58] The 2 is due to the fact that two down quarks (modulus of electric charge) are needed to obtain an up quark. The electrical charge will be:

$$q_u = \frac{2}{3} q \quad (86)$$

Quarks are not found in nature in a free state, but are always found in groups with other quarks. Therefore, its mass cannot be measured directly, so the standard model uses different calculation methods depending on the measurements made. Hence, the recommended value is an estimated value and not a measured one. So its mass varies a lot, in some cases, depending on the measurement system, as it happens in the up quark.

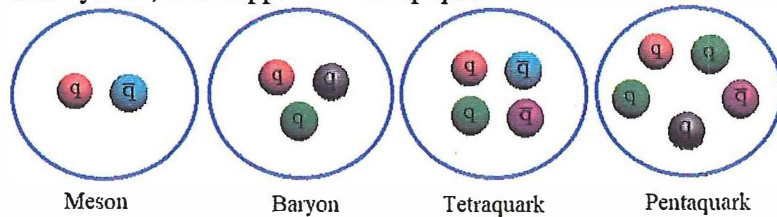


Figure 7. Combinations of 2, 3, 4 and 5 quarks

There are several 21st century particle physics experiments reporting the existence of tetraquarks, formed by the combination of two quarks and two antiquarks. The particle X(3872), is one of the first tetraquark candidates [59-61]. The diquark-antidiquark structure explains the properties of particle X(3872) well. [62]. *"If the X(3872) is not a pure $c\bar{c}$ state, the simplest explanation would appear to be that it is composed of two quark and two antiquarks ($c\bar{c}u\bar{u}$) and produced in B^+ decay."* [63]

The Z(4430) particle discovered in 2014 could also be a tetraquark. *"It therefore seems clear that the Z (4430) must be exotic with a minimal quark content of $c\bar{c}u\bar{d}$, but as before there is a major open question as to its internal structure."* [63]

There is also experimental evidence requiring a minimum of five quarks [64, 65]. *"It can be interpreted as a molecular meson-baryon resonance or alternatively as an exotic 5-quark state ($uudds^-$) that decays into a K^+ and a neutron."* [66] Evidence for the positive strangeness pentaquark is seen in the photoproduction of kaons with the SAPHIR detector at the Bonn Electron Stretcher Accelerator ELSA. [67] On the other hand, for other authors, the experimental evidence of pentaquarks is very weak. [68]

Baryons are combinations of 3 quarks, however combinations of two quarks with one antiquark are missing (Figure 8), such as down-anti-down higher or up-anti-up lower

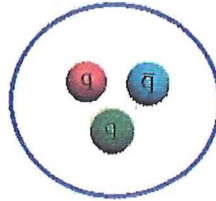


Figure 8. Combinations 2 quarks with antiquark

Strange quark

The strange quark, according to the standard model, is an elementary particle, which belongs to the second generation of quarks. Its electric charge is equal to $-1/3$ of the elementary charge and a with spin of $1/2$. The mass of the strange quark recommended by PDG [58], is:

$$m_s = 93^{+11}_{-5} \text{ MeV} \quad (87)$$

According to the developed model, the strange quark must be a particle composed of an up quark antiquark plus a down quark.

$$s = u\bar{u}d (J = 1/2) \quad (88)$$

The energy of the strange quark due to the up-anti-up combination will be the energy of the electromagnetic field at a distance equal to its Compton wavelength:

$$E_s = K \frac{q_u^+ q_{\bar{u}}^-}{\lambda_s} = K \frac{4}{9} \frac{q_e^- q_e^-}{\lambda_s} \quad (89)$$

In addition, we must take into account the coupling of the down quark with the up antiquark equals one electron. Therefore, the coupling will be between the electron and the up quark.

$$\alpha_u = \frac{q_e}{q_u / 2} = 3 \quad (90)$$

With what:

$$\alpha_u K \frac{q_u^+ q_{\bar{u}}^-}{\lambda_s} = 3 K \frac{4}{9} \frac{q_e^- q_e^-}{\lambda_s} = m_e c^2 \quad (91)$$

From where:

$$m_s = \frac{4}{3\alpha} m_e c^2 = 93,4 \text{ MeV} / c^2 \quad (92)$$

Where $m_e = 0,51099895 \text{ MeV}/c^2$ and $\alpha=0.0072973525693$. Depending on the method used to calculate the mass of the strange quark, it varies from $87.6 \pm 6.0 \text{ MeV}/c^2$ to $119.5 \pm 9.3 \text{ MeV}/c^2$. [58]

8.11 Calculation of Muon Mass

According to the Standard Model of Particle Physics, the electron, the muon and the tau are point particles, with the same charge and spin that basically differ in:

- The electron is stable, while the other two particles decay.
- The masses are different

The measured muon mass is $155.658 \text{ MeV}/c^2$ [58]. Let's assume that the muon is a particle composed of quark-antiquark plus an electron. Then, we have two types of muons:

- d-type muon: $\mu_d^- = d\bar{d}e^- (J = 1/2)$
- u-type muon: $\mu_u^- = u\bar{u}e^- (J = 1/2)$

The mass will be due to the rotation of the particles that constitute the muon. Rotation that is related to the charge of said particles. Therefore, the mass will be due to the energy of the electromagnetic field at a distance r equal to its wavelength λ_μ . Equating said energy to the energy of the electron E_e , it results:

$$E(r) = E(\lambda_\mu) = E_e \quad (93)$$

$$K \frac{q_e^- q_d^-}{r} + K \frac{q_e^- q_d^-}{r} = 2K \frac{q_e^- q_d^-}{r} = \frac{2}{3} K \frac{q_e^- q_e^-}{r} \quad (94)$$

For $r = \lambda_\mu$

$$\frac{2}{3} \frac{K q^2}{\lambda_\mu} = \frac{2}{3} \frac{K q^2}{\hbar c} m_\mu c^2 = m_e c^2 \quad (95)$$

It will be necessary to take into account other energies, such as the magnetic, the kinetic and potential of the quarks and the proper mass of the electron. Of all of them, the most important seems to be the mass of the electron, therefore, it turns out:

$$m_\mu = \frac{3}{2\alpha} m_e + m_e = 105,549 \text{ MeV} \quad (96)$$

For the combination $\mu^- = u\bar{u}e^- (J = 1/2)$, the mass will be given by:

$$K \frac{q_e^- q_u^-}{r} + K \frac{q_e^- q_u^-}{r} = 2K \frac{q_e^- q_u^-}{r} = \frac{4}{3} K \frac{q_e^- q_e^-}{2r} \quad (97)$$

The two in the denominator is due to the fact that two quarks are obtained above three positrons. [57]

8.12 Calculation of the Mass of the Higgs Boson

The Higgs boson is the particle responsible for giving mass to other particles and to itself. The Higgs mechanism was formulated in 1964 by Brout and Englert, and later by Higgs. According to this idea, the universe is made up of an invisible field, called the Higgs field. The friction of the particles with this field reduces their speed, so that the greater the resistance, the greater the mass. *The idea represents a great intellectual leap that, in a way, recovers the old notion of the ether, albeit in a completely new way.* [69]

The mathematical development of quantum field theory predicts that all fundamental bosons, responsible for interactions between particles, are not massive. However, the W (Weak) boson that carries the weak interaction has a non-zero mass. This was seen as a major flaw in quantum field theory. In 1964 Higgs developed a mathematical mechanism by which electroweak symmetry is broken locally. This is what is called “spontaneous symmetry breaking”. Due to this rupture, the Higgs bosons appear that give mass to the electroweak bosons and, in fact, interact more intensely the greater the mass of the particle.

The Higgs Boson generates the Higgs field that permeates all of space so that the elementary particles that interact with it acquire mass. However, the standard model does not predict the Higgs mass, which has to be measured experimentally. Nor does it predict the value of the mass of fermions, bosons and quarks, nor the value of some parameters that depend on the mass of the Higgs boson.

In short, 60 years after Higgs and two other groups of physicists independently developed the theory, all we have is a mathematical equation, which says that the mass of particles is proportional to a given mass, called the value of expectation. However, neither the expectation value, nor the proportionality constant, nor the mass of the particles can be calculated.

To calculate the mass of the Higgs boson, it is necessary to know its structure. To do this, you have to know some of its decays. At the LHC, the Higgs boson cannot be observed directly, but rather through its decay products. One possible decay is to two photons. It can also decay to two Z particles. The Z decays into a muon-antimuon pair. If both Z's decay in this way, then we will have four muons (figure 9).

The muon, in the model developed in this paper, is a particle composed of a down quark-antiquark plus an electron and whose mass is given by equation (90).

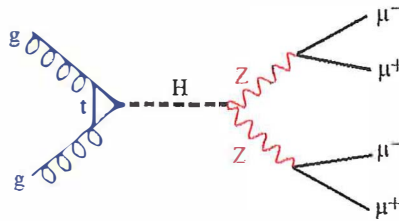


Figure 9. Higgs boson decay.

In the same way, the mass of the Higgs boson will be obtained from the mass of the muon (equation 95) for $r = \lambda_H/2\pi$

$$E_H = \frac{2}{3} K \frac{q_e^- q_e^-}{\lambda_H} \quad (98)$$

In addition, it will be necessary to take into account the coupling of the quarks of the other muon, which will be:

$$\alpha_d = K \frac{q_e^- q_d^-}{\hbar c} + K \frac{q_e^- q_d^-}{\hbar c} = 2K \frac{q_e^- q_d^-}{\hbar c} = \frac{2}{3} K \frac{q_e^- q_e^-}{\hbar c} = \frac{2}{3} \alpha \quad (99)$$

We must also take into account the coupling of the electron, which will be:

$$\alpha_e = \frac{q_e^-}{q_p} = \sqrt{K \frac{q_e^- q_e^-}{\hbar c}} = \sqrt{\alpha} \quad (100)$$

where q_p is the Planck charge. Finally, as we have two Z particles, it results:

$$E_H = 2\alpha_e \alpha_d \frac{2}{3} K \frac{q_e^- q_e^-}{\lambda_H} = m_e c^2 \quad (101)$$

From where,

$$m_H = \frac{1}{2\sqrt{\alpha}} \frac{3}{2\alpha} \frac{3}{2\alpha} m_e = 126,37 \text{ GeV}/c^2 \quad (102)$$

Where $m_e = 0,51099895 \text{ MeV}/c^2$ is the mass of the electron and $\alpha=0.00729735256$ is the fine structure constant. Value that falls within the limits of mass given by "Particle Data Group" that is between 122 ± 7 and $126.8 \pm 0.2 \pm 0.7 \text{ GeV}/c^2$. The value recommended by "Particle Data Group" is: $m = 125.10 \pm 0.14 \text{ GeV}/c^2$. [58]

8.13 Calculation of the Z Boson Mass

If the Higgs boson decays into two Z particles, in principle, the mass of each Z boson should be half the mass of the Higgs. However, it must be taken into account that since the Z particle is neutral, the two Z particles join due to the gravitational force, as occurs with neutrons. Therefore, there will be a loss of mass, because the union of two neutral particles decreases the volume of the whole and therefore, the energy of the electromagnetic field of the two Z bosons, which form the Higgs boson, is lower than the sum of the masses of the two Z bosons.

$$m_H = 2m_Z - \Delta m \quad (103)$$

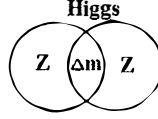


Figure 10. Mass defect as the Higgs decays in two Z bosons

On the other hand, if the Z boson decays into muon-antimuon, the simplest thing is that it is formed by these two particles (figure 11)

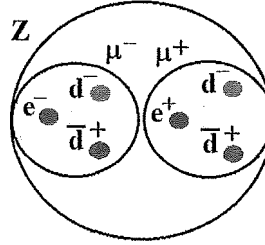


Figure 11. The two muons interact to form a boson

In this case, since the muons are charged particles, they interact with each other, so that

$$2\alpha_d\alpha_e K \frac{q_\mu^- q_\mu^+}{\lambda_z} = m_e c^2 \quad (104)$$

Where, α_d is due to the coupling of the quarks of each muon, α_e is due to the coupling of the electron of each muon and the 2 is due to the 2 muons.

$$m_z = \frac{1}{2\alpha\sqrt{\alpha}} \frac{3}{2\alpha} m_e = 84,25 \text{ GeV} / c^2 \quad (105)$$

Where $m_e = 0.51099895 \text{ MeV}/c^2$ and $\alpha = 0.0072973525693$. The value given by PDG, $\Gamma(\mu + \mu) = 83.99 \pm 0.18 \text{ GeV} / c^2$. [58]

9 Errors and Measurements

Most of the fundamental constants are measured very precisely. For example, the mass of the electron is measured with a relative standard uncertainty of 3.0×10^{-10} . While in this work, for the calculation of the relative error of the electron, the following formula has been used:

$$\text{Error}\% = \frac{|V_m - V_c|}{V_m} 100 \quad (106)$$

Where V_m the measured value and V_c the calculated value, which gives for the mass of the electron an error of:

$$Error = \frac{9.1093837015 \times 10^{-31} - 9.086 \times 10^{-31}}{9.1093837015 \times 10^{-31}} = 2.57 \times 10^{-3} \quad (107)$$

Which is 7 orders of magnitude larger, which may seem very large at first, for a calculation of a fundamental magnitude. But consider, for example, the mass of the up quark, which does not exist free in nature and therefore has to be calculated from other parameters. In this case, different calculation methods are used, from which PDG recommends a value. Let's look at a couple of measures:

- *Dominguez determine the quark mass from a QCD finite energy sum rule for the divergence of the axial current.* [58] This gives a value of: 2.6 ± 04 .
- *Deandrea determine $m_u - m_d$ from $\eta \rightarrow 3\pi^0$, and combine with the PDG 06 lattice average value of $m_u + m_d = 7.6 \pm 1.6$ to determine m_u and m_d .* [58] This gives a value of: 2.9 ± 08 .

If we take into account the maximum value measured, which is: 3.02 ± 0.33 and we compare it with the minimum, which is: 1.70 ± 0.3 . The relative error between the maximum and minimum values would be:

$$Error = \frac{3.03 - 1.7}{3.03} = 4.39 \times 10^{-1} \quad (108)$$

Or what is the same, the difference between the maximum and minimum value is 43.9%. That is, the standard model does not allow the fundamental constants to be calculated even approximately..

10 Conclusion

Many of the constants are due to the mass of the various fermions and bosons which the Standard Model does not predict, but simply measures using different methods. After measuring the different values, Particle Data Group recommends a certain value. In addition, it assigns the value of the mass to the interaction of the particles with the Higgs field, produced by the Higgs boson, whose mass the standard model is also unable to predict..

Instead, as we have seen, if the particles are assumed to be rotating 4D spheres, the charge can be attributed to the period of that rotation. Therefore, the mass will be due to the rotation of the particles or to the energy of the electromagnetic field, with which the mass of most particles can be easily calculated.

On the other hand, the speed of light is fixed by defining the meter as a unit of length and the second as a unit of time. At the same time, the values of the Planck length and time respectively corresponding to the 4D sphere of Planck are fixed. With this, the constants $l_p c$, $l_p c^2$ and the product of both $l_p c \times l_p c^2$ are determined.

The value of the Planck mass (m_p) is determined by defining the kilogram as the unit of mass, with which the constant $l_p c^2$ is separated into two: Planck mass and Gravitation constant, $G = l_p c^2 / m_p$. Also the product $l_p c \times l_p c^2$ separates into two, Planck's constant and Gravitation constant: $m_p l_p c \times l_p c^2 / m_p = \hbar \times G$

By defining the coulomb as the unit of electric charge, the value of Planck's electric charge (q_p) and that of Coulomb's law constant, which depends on the constant $l_p c^2$ and on the mass and electric charge of Planck, are fixed. $K = l_p c^2 m_p / q_p^2$

On the other hand, on the 4D Planck sphere the gravitational and Coulomb forces are equal. But Planck's 4D sphere decreases its rotation until it reaches of electron conditions so that Coulomb's law, under Planck's conditions, verifies $F_q = \alpha F_p$, where F_p is the Planck force.

The negative charge of electrons and the positive charge of positrons is determined by the direction of rotation of the 4D Planck sphere. Electrons and positrons combine in such a way that three electrons make one down quark and three positrons make two up quarks. The quarks combine to give rise to the second and third generation particles, as well as the rest of the compound particles. The compound particles in turn decay giving rise to photons and neutrinos. So it all boils down to space in movement.

When comparing the calculated values of the fundamental constants carried out in this work, with the values calculated by the standard model, it is observed that with only two constants it is enough to determine the value of the remaining fundamental constants. The only constants of nature, independent of the speed of any observer, are the Planck length and the Planck time, or what is the same, the Planck length and the speed of light.

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